Environment

SHANKAR IAS ACADEMY

The Best IAS Academy in South India

SHOUT
SHARE
IT

ENVIRONMENT

S
SHANKAR IAS ACADEMY
Sculpting Minds: Catalyzing Success

SHANKAR IAS ACADEMY
Plot No.1742, Ist Floor, 18th Main Road, Anna Nagar, Chennai – 600 040.
Phone : 044-26216435, 64597222, 4353 3445, Mobile : 94441 66435
www.shankariasacademy.com

©

SHANKAR IAS ACADEMY

1st Edition – 2012
2nd Edition - 2013

Pages : 304 (282+xxii)

Published by
SHANKAR IAS ACADEMY
Plot No.1742, Ist Floor, 18th Main Road,
Anna Nagar, Chennai – 600 040.
Phone : 044-26216435, 64597222, 4353 3445,
Mobile : 94441 66435
www.shankariasacademy.com
Email : enquiry@shankariasacademy.com

© Copyright is reserved to the publisher, therefore the person who will try to intimate or to print this book illegally or without the prior written permission of this publisher in any form, will be responsible for the loss and may be punished for compensation under the copyright act.

Dedicated to

OUR

MOTHER EARTH

"Earth provides enough to satisfy every man's need but not every man's greed"

- M.K. Gandhi

PREFACE

India - A land of high species richness and endemism as well as of agro-biodiversity, India, with only 2.4% of the world's landmass, supports an astounding 8.1% of the world's biodiversity. She also supports 17.5% of the world's human as well as 18% of the world's cattle population. In fact, an estimated 70% of India's population is dependent locally on natural ecosystems for subsistence means of livelihood, including fuel, housing, food, water, and security of health. Consequently, the country's biodiversity faces immense pressure.

The environmental problems in India are growing rapidly. The increasing economic development and a rapidly growing population are putting a strain on the environment, biodiversity, and the country's natural resources. Industrial pollution, soil erosion, deforestation, poaching, rapid industrialization, urbanization, and land degradation are all worsening problems. Overexploitation of the country's resources, be it land or water has resulted in the environmental degradation.

There is so far a positive of information for the student and general public on Environment.

I am pleased to therefore introduce this book "ENVIRONMENT", which covers on Environmental Ecology, Bio-diversity and Climate Change with reference to India, a pioneering attempt by the **SHANKAR IAS ACADEMY**, presented in a concise and visually appealing format to raise the level of knowledge and awareness among the people from all walks of life.

This book is exclusively prepared for all aspirants who prepare for Civil Services Examination and other Competitive exams.

"We Need Ecological Growth Not Mere Economic Growth"
"Nature Protects If She Is Protected"

ALL THE BEST

D. SHANKAR
DIRECTOR
SHANKAR IAS ACADEMY

FOREWORD

The pursuit of economic development by humanity over the centuries has led to a devastating impact on our environment and all living things. Since the last two decades the international community has been witnessing various challenges, both local & global, on the environmental front - Climate Change, Greenhouse Gases, Depletion of Ozone Layer, Deforestation, Desertification, and Loss of Biological Diversity to name a few. This scenario has forced global leaders to find a balanced solution, a solution which takes care of the environment while at the same time ensuring material progress and prosperity for mankind. .

These issues are a major concern for policy makers across the world and more so in a developing country like India. The Civil Service Aspirants of today might turn into Policy Makers tomorrow. Taking this as cue, this book "ENVIRONMENT" has been designed in order to bring about an understanding on basic issues of Environment Ecology, Bio-diversity and Climate Change. The author has taken immense effort to enrich the knowledge of aspirants, student community and the general public on Environment. The **SHANKAR IAS ACADEMY** has left no stone unturned in bringing this edition on our environment.

ABHIRAM G. SANKAR IAS
2011 Batch

CONTENT

Previous Year UPSC Question paper analysis xvi

PART-I

ENVIRONMENT ECOLOGY

1. ECOLOGY 3-9
   - ➢ HISTORY OF ECOLOGY 3
   - ➢ ENVIRONMENT & ITS COMPONENTS 3
   - ➢ LEVELS OF ORGANISATION 4

2. FUNCTIONS OF AN ECOSYSTEM 10-20
   - ➢ ENERGY FLOW 10
   - ➢ FOOD CHAIN 10
   - ➢ FOOD WEB 11
   - ➢ ECOLOGICAL PYRAMID 12
   - ➢ POLLUTANTS & TROPHICAL LEVEL 14
   - ➢ BIOTIC INTERACTION 15
   - ➢ BIO-GEOCHEMICAL CYCLE 15
   - ➢ ECOLOGICAL SUCCESSION 19

3. TERRESTRIAL ECOSYSTEM 21-30
   - ➢ TUNDRA 21
   - ➢ FOREST ECOSYSTEM 21
   - ➢ INDIAN FOREST TYPES 23
   - ➢ DEFORESTATION 24
   - ➢ GRASSLAND ECOSYSTEM 26
   - ➢ DESERT ECOSYSTEM (THAR & COLD) 27
   - ➢ DESERTIFICATION 30

4. AQUATIC ECOSYSTEM 31-48
   - ➢ AQUATIC ORGANISM 31
   - ➢ LAKE ECOLOGY 33
   - ➢ EUTROPHICATION 34
   - ➢ WETLAND ECOSYSTEM 37
   - ➢ NATIONAL WETLAND CONSERVATION PROGRAMME 40
   - ➢ ESTUARY ECOSYSTEM 41

- MANGROVE ECOSYSTEM 43
- CORAL REEFS 45
- CORAL BLEACHING 46
- INTIATIVES TO PROTECT COASTAL ENVIRONMENT 48

5. **ENVIRONMENTAL POLLUTION 49-70**
   - POLLUTANT 49
   - AIR POLLUTION 49
     - SMOG 50
     - INDOOR AIR POLLUTION 51
     - FLY ASH 52
     - NAMP & NAAQ 55
   - WATER POLLUTION 55
   - SOIL POLLUTION 58
   - NOISE POLLUTION 60
   - RADIO ACTIVE POLLUTION 61
   - E-WASTE 62
   - SOLID WASTE 65
   - BIO-REMEDIATION 67

6. **ENVIRONMENTAL IMPACT ASSESSMENT 69-78**
   - THE NEED FOR EIA 69
   - SALIENT FEATURES OF EIA NOTIFICATION - 1994 71
   - EIA CYCLE AND ITS PROCEDURES 73
   - COMPONENTS OF EIA 75
   - PROCEDURE OF PUBLIC HEARING 77

PART-II

BIODIVERSITY

7. **BIODIVERSITY 80-84**
   - BIODIVERSITY 80
   - LEVELS OF BIODIVERSITY 80
   - MEASUREMENT OF BIODIVERSITY 81
   - BIODIVERSITY SERVICES 82
   - MODES OF CONSERVATION 83
   - BOTANICAL GARDEN & ZOO 83

8. **INDIAN BIODIVERSITY 84-92**
   - INDIAN BIO-GEOGRAPHICAL CLASSIFICATION 84
   - FAUNA DIVERSITY 86
   - FLORA DIVERSITY 88
   - INDIAN WILDLIFE 90

9. ANIMAL DIVERSITY OF INDIA....93-106
- RED BOOK DATA....93
- IUCN CLASSIFICATION....93
- CRITICALLY ENDANGERED MAMMALS....98
- ENDANGERED MAMMALS....96
- VULNERABLE MAMMALS....98
- MARINE MAMMALS....99
- EGG LAYING MAMMALS....99
- MARSUPIAL....100
- CRITICALLY ENDANGERED BIRDS....100
- CRITICALLY ENDANGERED REPTILES....102
- CRITICALLY ENDANGERED FISHES....103
- CRITICALLY ENDANGERED SPIDERS & CORAL....104
- BIRD MIGRATION....104
- WILD LIFE DISEASE....105
- SPECIES EXTINCTION.... 105
- MAN- ANIMAL CONFLICT....106

10. PLANT DIVERSITY OF INDIA....107-115
- PLANT CLASSIFICATION....107
- EFFECT OF ABIOTIC COMPONENTS ON PLANTS....107
- INSECTIVOROUS PLANT....108
- INVASIVE ALIEN SPECIES....110
- INVASIVE ALIEN FLORA OF INDIA....110
- MEDICINAL PLANTS....112
- TREE CHARACTERS....113

11. MARINE ORGANISM....116-119
- PLANKTON....116
- PHYTO-PLANKTON....116
- ZOO-PLANKTON....118
- SEA GRASS....118
- SEA WEED....119

12. PROTECTED AREA NETWORK....120-134
- NATIONAL INITIATIVE
  - WILDLIFE SANCTUARY & NATIONAL PARKS....120
  - CONSERVATION RESERVES & COMMUNITY RESERVES....122
  - COSTAL PROTECTED AREAS....122
  - SACRED GROVES OF INDIA....123
  - EXPORT PROHIBITED ITEMS....124

➢ GLOBAL INITIATIVE
  - MAN AND BIOSPHERE 125
  - BIOSPHERE RESERVES 125
  - NATIONAL BIOSPHERE RESERVE PROGRAMME 127
  - WORLD NETWORK OF BIOSPHERE RESERVES 129
  - BIODIVERSITY HOTSPOTS 130
  - WORLD HERITAGE SITES 132

13. CONSERVATION EFFORTS 135-147
➢ PROJECT TIGER 135
➢ PROJECT ELEPHANT 138
➢ VULTURE 140
➢ ONE HORNED RHINOCEROS 143
➢ PROJECT SNOW LEOPARD 144
➢ SEA TURTLE PROJECT 145
➢ CROCODILE CONSERVATION PROJECT 145
➢ PROJECT HANGUL 146
➢ CAPTIVE BREEDING 146
➢ GANGES DOLPHIN 146
➢ SCHEDULE LIST - WPA, 1972 147

PART-III

CLIMATE CHANGE

14. CLIMATE CHANGE 149-157
➢ GLOBAL WARMING 149
➢ GREEN HOUSE EFFECT 150
➢ GREEN HOUSE GASES 151
➢ CLIMATE FORCING 154
➢ GLOBAL WARMING POTENTIAL 155
➢ GLOBAL EMMISSIONS 156

15. ACIDIFICATION 158-164
➢ ACID RAIN 158
➢ OCEAN ACIDIFICATION 162

16. OZONE HOLE 165-169

17. IMPACT OF CLIMATE CHANGE – INDIA 170-175
➢ AGRICULTURE & FOOD SECURITY 170
➢ WATER STRESS & WATER INSECURITY 171
➢ SEA LEVEL RISE 172
➢ ECOSYSTEM & BIODIVERSITY 173
➢ CLIMATE CHANGE & HEALTH 174

18. MITIGATION STRATEGIES 176-180
- CARBON SEQUESTRATION 176
- CARBON SINK 177
- CARBON CREDIT 178
- CARBON OFFSETTING 178
- CARBON TAX 179
- GEO-ENGINEERING 179

19. INDIA AND CLIMATE CHANGE 181-198
- INDIA'S POSITION ON CLIMATE CHANGE 181
- OBSERVED CLIMATE AND WEATHER CHANGES IN INDIA 182
- CORRECT ACTIONS FOR ADAPTATION AND MITIGATION 182
- NATIONAL ACTION PLAN ON CLIMATE CHANGE 183
- INDIAN NETWORK ON CLIMATE CHANGE ASSESSMENT 189
- NATIONAL COMMUNICATION (NATCOM) 190
- INDIA'S POLICY STRUCTURE RELEVANT TO GHG MITIGATION 191
- GREEN BUILDING 192
- GRIHA 193
- NATIONAL INITIATIVE ON CLIMATE RESILIENT AGRICULTURE 196
- BSE GREENEX 197
- 24 OTHER CRITICAL ENTITIES 198

20. CLIMATE CHANGE ORGANISATIONS 199-211
- UNFCC 199
- KYOTO PROTOCOL 199
- BALI MEET 201
- COPENHAGEN SUMMIT 202
- CANCUN SUMMIT 202
- DURBAN SUMMIT 204
- OTHER MECHANISM OF UNFCC 205
- REDD AND REDD+ 205
- GLOBAL ENVIRONMENT FACILITIES 207
- CLIMATE SMART AGRICULTURE 207
- IPCC 208
- NATIONAL GREEN HOUSE GAS INVENTORIES PROGRAMME 209
- GREEN ECONOMY 210

PART-IV

AGRICULTURE

21. AGRICULTURE 213-229
- CROP AND ITS CLASSIFICATION 214
- CROPPING SYSTEM AND PATTERN 218
- FARMING SYSTEM 220
- SUSTAINABLE AGRICULTURE 221
- INTEGRATED FARMING SYSTEM 222
- SOIL SCIENCE 225

PART-V

22. ACTS AND POLICIES 231-236
- WILD LIFE PROTECTION ACT 1972 231
- ENVIRONMENTAL PROTECTION ACT 1986 232
- NATIONAL FOREST POLICY 1988 233
- BIOLOGICAL DIVERSITY ACT 2002 233
- SCHEDULE TRIBES AND OTHER FOREST DWELLERS ACT 2006 234
- COASTAL REGULATION ZONE 235
- WETLAND RULES 2010 236
- NATION GREEN TRIBUNAL 236
- THE OZONE DEPLETING SUBSTANCES RULES 236

23. INSTITUTION AND MEASURES 237-243
- NATIONAL WIDE LIFE ACTION PLAN 237
- NATIONAL AFFORESTATION AND ECO-DEVELOPMENT BOARD 237
- CAMPA 238
- JOINT FOREST MANAGEMENT 238
- SOCIAL FORESTRY 239
- NATIONAL BAMBOO MISSION 240
- CEPI 240
- LIGHTING A BILLION LIVES 240
- ECO-MARK 241
- USERS 241
- BCRLIP 241
- NATIONAL CLEAN ENERGY FUND 241
- NATIONAL MISSION FOR ELECTRIC MOBILITY 242
- SCIENCE EXPRESS - BIO DIVERSITY SPECIAL 242
- MANGROVE FOR FUTURE 243

24. ENVIRONMENTAL ORGANISATIONS 244-247

- ANIMAL WELFARE BOARD 244
- CENTRAL ZOO AUTHORITY 245
- NATIONAL BIO DIVERSITY AUTHORITY 245
- WILDLIFE CRIME CONTROL BUREAU 246
- NATIONAL LAKE CONSERVATION PLAN 246
- NATIONAL GANGA RIVER BASIN AUTHORITY 247

25. INTERNATIONAL ENVIRONMENTAL CONVENTIONS 248-263

- UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT 248
- CONVENTION ON BIOLOGICAL DIVERSITY (CBD) 249
- RAMSAR CONVENTION ON WETLANDS 254
- CITES 255
- THE WILDLIFE TRADE MONITORING NETWORK (TRAFFIC) 256
- CONVENTION ON THE CONSERVATION OF MIGRATORY SPECIES (CMS) 256
- COALITION AGAINST WILDLIFE TRAFFICKING (CAWT) 256
- INTERNATIONAL TROPICAL TIMBER ORGANIZATION (ITTO) 257
- UNITED NATIONS FORUM ON FORESTS (UNFF) 257
- IUCN 258
- GLOBAL TIGER FORUM (GTF) 259
- STOCKHOLM CONVENTION 260
- BASEL CONVENTION 260
- ROTTERDAM CONVENTION 261
- UNITED NATIONS CONVENTION TO COMBAT DESERTIFICATION 261
- INTERNATIONAL WHALING COMMISSION (IWC) 262
- VIENNA CONVENTION AND MONTREAL PROTOCOL 262

26. ENVIRONMENT ISSUES AND HEALTH EFFECTS 264-269

GLOSSARY 270

APPENDIX 278

◆◆◆◆◆◆

PRELIMINARY - PREVIOUS YEAR QUESTION PAPER

ENVIRONMENTAL ECOLOGY & BIODIVERSITY

2011	2012
1. Consider the following statements : 1. Biodiversity is normally greater in the lower latitudes as compared to the higher latitudes. 2. Along the mountain gradients, biodiversity is normally greater in the lower altitudes as compared to the higher altitudes. Which of the statements given above is/are correct? a. 1 only b. 2 only c. Both 1 and 2 d. Neither 1 nor 2	***1. Which of the following can be threats to the biodiversity of a geographical area ?*** 1. Global warming 2. Fragmentation of habitat 3. Invasion of alien species 4. Promotion of vegetarianism Select the correct answer using the codes given below. a. 1, 2 and 3 only b. 2 and 3 only c. 1 and 4 only d. 1, 2, and 4
2. Three of the following criteria have contributed to the recognition of Western Ghats – Sri Lanka and Indo-Burma regions as hotspots of bio-diversity. 1. Species richness 2. Vegetation density 3. Endemism 4. Ethno-botanical importance 5. Threat perception 6. Adaptation of flora and fauna to warm and humid conditions Which three of the above are correct criteria in this context ? a. 1, 2 and 6 b. 2, 4 and 6 c. 1, 3 and 5 d. 3, 4 and 6	**2. In which one among the following categories of protected areas in India are local people not allowed to collect and use the biomass?** a. Biosphere Reserves b. National Parks c. Wetlands declared under Ramsar Convention d. Wildlife Sanctuaries
3. Biodiversity forms the basis for human existence in the following ways : a. Soil formation b. Prevention of soil erosion c. Recycling of waste d. Pollination of crops Select the correct answer using the codes given below : a. 1,2 and 3 only b. 2,3 and 4 only c. 1 and 4 only d. 1,2,3 and 4	**3. Consider the following protected areas** 1. Bandipur 2. Bhitarkanika 3. Manas 4. Sunderbans Which of the above are declared Tiger Reserves? a. 1, 3 and 2 only b. 1, 3 and 4 only c. 2, 3 and 4 only d. 1, 2, 3 and 4

4. Which one of the following is not a site for in-situ method of conservation of flora?

a. Biosphere Reserves
b. Botanical Garden
c. National Park
d. Wildlife Sanctuary

4. What is the difference between the antelopes Oryx and Chiru?

a. Oryx is adapted to live in hot and arid areas whereas Chiru is adapted to live in steppes and semi-desert areas of cold high mountains.
b. Oryx is poached for its antlers whereas Chiru is poached for its musk.
c. Oryx exists in western India only whereas Chiru exists in north-east India only.
d. None of the statements a, b, and c given above is correct.

5. Among the following States, which one has the most suitable climatic conditions for the cultivation of a large variety of orchids with minimum cost of production, and can develop an export oriented industry in this field ?

a. Andhra Pradesh
b. Arunachal Pradesh
c. Madhya Pradesh
d. Uttar Pradesh

5. Consider the following :

1. Black-necked crane
2. Cheetah
3. Flying squirrel
4. Snow leopard

Which of the above are naturally found in India ?

a. 1,2 and 3 only
b. 1,3 and 4 only
c. 2 and 4 only
d. 1,2,3 and 4

6. A sandy and saline area is the natural habitat of an Indian animal species. The animal has no predators in that area but its existence is threatened due to the destruction of its habitat. Which one of the following could be that animal ?

a. Indian wild buffalo
b. Indian wild ass
c. Indian wild boar
d. Indian Gazelle

6. Consider the following kinds of organisms

1. Bat
2. Bee
3. Bird

Which of the above is/are pollinating agent / agents ?

a. 1 and 2 only
b. 2 only
c. 1 and 3 only
d. 1, 2 and 3

7. The "Red Data Books' published by the International Union for Conservation of Nature and Natural Resources (IUCN) contain lists of

a. Endemic plant and animal species present in the biodiversity hotspots.
b. Threatened plant and animal species.
c. Protected sites for conservation of nature & natural resources in various countries.

Which of the statement given above is / are correct ?

a. 1 & 3
b. 2 only
c. 2 & 3
d. 3 only

7. Which one of the following groups of animals belongs to the category of endangered species?

a. Great Indian Bustard, Musk Deer, Red Panda and Asiatic Wild Ass
b. Kashmir Stag, Cheetal, Blue Bull and Great Indian Bustard
c. Snow Leopard, Swamp Deer, Rhesus Monkey and Saras (Crane)
d. Lion-tailed Macaque, Blue Bull, Hanuman Langur and Cheetal

8. In the context of eco-system productivity, marine upwelling zones are important as they increase the marine productivity by bringing the

1. Decomposer microorganisms to the surface.
2. Nutrients to the surface.
3. Botton-dwelling organisms to the surface.

Which of the statements given above is/are correct ?

a. 1 and 2
b. 2 only
c. 2 and 3
d. 3 only

8. What would happen if phytoplankton of an ocean is completely destroyed for some reason?

1. The ocean as a carbon sink would be adversely affected.
2. The food chains in the ocean would be adversely affected.
3. The density of ocean water would drastically decrease.

Select the using codes given below :

a. 1 and 2 only
b. 2 only
c. 3 only
d. 1,2 and 3

9. The 2004 Tsunami made people realize that mangroves can serve as a reliable safety hedge against coastal calamities. How do mangroves function as a safety hedge ?

a. The mangroves swaps separate the human settlements from the sea by a wide zone in which people neither live nor venture out
b. The mangroves provide both food and medicines which people are in need of after any natural disaster.
c. The mangroves trees are tall with dense canopies and serve as an excellent shelter during a cyclone or tsunami
d. The mangroves trees do not get uprooted by storms and tides because of their extensive roots.

9. With reference to the wetlands of India, consider the following statements :

1. The country's total geographical area under the category of wetlands is recorded more in Gujarat as compared to other States.
2. In India, the total geographical area of coastal wetlands is larger than that of inland wetlands.

Which of the statements given above is/are correct ?

a. 1 only
b. 2 only
c. Both 1 and 2
d. Neither 1 nor 2

10. There is a concern over the increase in harmful algal blooms in the seawaters of India. What could be the causative factors for this phenomenon ?

1. Discharge of nutrients from the estuaries.
2. Run-off from the land during the monsoon.
3. Upwelling in the seas.

Select the correct answer from the codes given below :

a. 1 only
b. 1 and 2 only
c. 2 and 3 only
d. 1,2 and 3

10. Vultures which used to be very common in Indian countryside some years age are rarely seen nowadays. This is attributed to

a. the destruction of their nesting sites by new invasive species.
b. a drug used by cattle owners for treating their diseased cattle.
c. scarcity of food available to them
d. a widespread, persistent and fatal disease among them

11. The Himalayan Range is very rich in species diversity. Which one among the following is the most appropriate reason for this phenomenon ?

a. It has a high rainfall that supports luxuriant vegetative growth.

b. It is a confluence of different bio geographical zones.

c. Exotic and invasive species have not been introduced in this region.

d. It has less human interference.

12. If a tropical rain forest is removed, it does not regenerate quickly as compared to a tropical deciduous forest. This is because

a. the soil of rain forest is deficient in nutrients

b. propagules of the trees in a rain forest have poor viability

c. the rain forest species are slow-growing

d. exotic species invade the fertile soil of rain forest.

13. When the bark of a tree is removed in a circular fashion all around near its base, it generally dries up and dies because

a.. Water from soil cannot rise to aerial parts.

b. Roots are starved of energy

c. Tree is infected by soil microbes

d. Roots do not receive oxygen for respiration

CLIMATE CHANGE

14. Consider the following :

1. Photosynthesis
2. Respiration
3. Decay of organic matter
4. Volcanic action

Which of the above add carbon dioxide to the carbon cycle on Earth ?

a. 1 and 4 only

b. 2 and 3 only

c. 2,3 and 4 only

d. 1, 2, 3 and 4

11. Consider the following statements : Choloroflourocarbons, known as ozone-depleting substances, are used

1. in the production of plastic foams
2. in the production of tubeless tyres
3. in cleaning certain electronic components
4. as pressurizing agents in aerosol cans

Which of the statements given above is/are correct?

a. 1, 2 and 3 only

b. 4 only

c. 1, 3 and 4 only

d. 1, 2, 3 and 4

15. Consider the following :

1. Carbon dioxide
2. Oxides of Nitrogen
3. Oxides of Sulphur

Which of the above is/are the emission / emissions from coal combustion at thermal power plants ?

a. 1 only
b. 2 and 3 only
c. 1 and 3 only
d. 1,2 and 3

16. The formation of ozone hole in the Antartic region has been a cause of concern. What could be the reason for the formation of this hole ?

a. Presence of prominent tropospheric turbulence; and inflow of chlorofluoro carbons
b. Presence of prominent polar front and stratospheric clouds; and inflow of chloro fluorocarbons
c. Absence of polar front and stratospheric clouds; and inflow of methane and chloro fluorocarbons.
d. Increased temperature at polar region due to global warming

17. Regarding "carbon credits", which one of the following statements is not correct ?

a. The carbon credit system was ratified in conjunction with the Kyoto Protocol
b. Carbon credits are awarded to countries or groups that have reduced greenhouse gases below their emission quota
c. The goal of the carbon credit system is to limit the increase of carbon emission quota
d. Carbon credits are traded at a price fixed from time to time by the United Nations Environment Programme.

12. The increasing amount of carbon dioxide in the air is slowly raising the temperature of the atmosphere, because it absorbs

a. the water vapour of the air and retains its heat.
b. the ultraviolet part of the solar radiation.
c. all the solar radiations.
d. the infrared part of the solar radiation

13. The acidification of oceans is increasing. Why is this phenomenon a cause of concern ?

1. The growth and survival of calcareous phytoplankton will be adversely affected.
2. The growth and survival of coral reefs will be adversely affected.
3. The survival of some animals that have phytoplanktonic larvae will be adversely affected.
4. The cloud seeding and formation of clouds will be adversely affected.

Which of statements given above is / are correct ?

a. 1,2 and 3 only
b. 2 only
c. 1 and 3 only
d. 1,2,3 and 4

ACT & POLICIES

18. With reference to India, consider the following Central Acts :

1. Import and Export (Control) Act, 1947.
2. Mining and Mineral Development (Regulation) Act, 1957
3. Customs Act, 1962
4. Indian Forest Act, 1927

Which of above Acts have relevance to / bearing on the biodiversity conservation in the country ?

a. 1 and 3 only
b. 2,3 and 4 only
c. 1,2,3 and 4
d. None of the above Acts

14. The National Green Tribunal Act, 2010 was enacted in consonance with which of the following provisions of the Constitution of India?

1. Right to healthy environment, construed as a part of part of Right to life under Article 21.
2. Provision of grants for raising the level of administration in the Scheduled Areas for the welfare of Scheduled Tribes under Article 275(1)

Which of the statements given above is/are correct ?

a. 1 only
b. 2 only
c. Both 1 and 2
d. Neither 1 nor 2

15. How does National Biodiversity Authority (NBA) help in protecting the Indian agriculture?

1. NBA checks the biopiracy and protects the indigenous and traditional genetic resources.
2. NBA directly monitors and supervises the scientific research on genetic modification of crop plants.
3. Application for intellectual Property Rights related to genetic / biological resources cannot be made without the approval of NBA.

Which of the statements given above is/are correct?

a. 1 only
b. 2 and 3 only
c. 1 and 3 only
d. 1, 2 and 3

CURRENT AFFAIRS

19. Recently, 'oilzapper' was in the news. What is it ?

a. It is an eco-friendly technology for the remediation of oil sludge and oil spills.
b. It is the latest technology developed for under-sea oil exploration.
c. It is a genetically engineered high biofuel yielding maize variety.
d. It is the latest technology to control the accidentally caused flames from oil wells.

16. Government of India encourages the cultivation of 'sea buckthorn'. What is the importance of this plant ?

a. It helps in controlling soil erosion and in preventing desertification.
b. It is a rich source of biodiesel.
c. It has nutritional value and is well-adapted to live in cold areas of high altitudes.
d. Its timber is of great commercial value.

MAP BASED QUESTION

20. Two important rivers – one with its source in Jharkhand (and known by a different name in Odisha), and another, with its source in Odisha – merge at a place only a short distance from the coast of Bay of Bengal before flowing into the sea. This is an important site of wildlife and bio-diversity and a protected area. Which one of the following could be this ?

a. Bhitarkanika
b. Chandipur-on-sea
c. Gopalpur-on-sea
d. Simlipal

17. A particular State in India has the following characteristics :

1. It is located on the same latitude which passes through northern Rajasthan.
2. It has over 80% of its area under forest cover.
3. Over 12% of forest cover constitutes Protected Area Network in this State.

Which one among the following States has all the above characteristics?

a. Arunachal Pradesh
b. Assam
c. Himachal Pradesh
d. Uttarakhand

2011 - Answers	2012 - Answers
1(c), 2(c), 3(d), 4(b), 5(b), 6(b), 7(b), 8(b), 9(d), 10(c), 11(b), 12(a), 13(a), 14(c), 15(d), 16(b), 17(d), 18(c), 19(a), 20(a)	**1(a), 2(b), 3(b), 4(a), 5(b), 6(d), 7(a), 8(a), 9(a), 10(b), 11(d), 12(d), 13(a), 14(a), 15(c), 16(a), 17(a)** **(Q.no. 7 is disputed)**

UPSC MAINS EXAMINATION

PAPER 1

2011	2012
Evolution of Green Benches (12 marks)	Causes and the Extent of 'Desertification' in India and Remedial Measures (25 marks)
Impact of C.C. on Indian water resources (12 marks)	Endosulphan (25 marks)
Phase IV of tiger monitoring programme (5 marks)	Tiger tourism (25 marks)

PAPER 2

2011	2012
E-waste (5 marks)	Permaculture (12 marks)
Diminishing population of Vulture (5 marks)	CBD (5 marks)
Billion Acts of Green (2 marks)	Environment Sustainability (5 marks)

◆ ◆ ◆

PART - I

CHAPTER - 1

ECOLOGY પરિસ્થિતિ વિજ્ઞાન- परिस्थितिकी

Ecology is a scientific study of the reciprocal relationship between organisms (including microbes, plants, animals, man) with their environment. It deals with the ways in which organisms are moulded by their environment, how they make use of environmental resources including energy flow and mineral cycling.

The term ecology was coined only as late as 1868. It has been derived from two Greek words namely, 'Oikos' meaning home or place to live in and 'logos' meaning study. Literally it is the study of the home of nature.

Ecology is defined "as a scientific study of the relationship of the living organisms with each other and with their environment."

1.1. HISTORY OF ECOLOGY

The roots of ecology lie in Natural History, which is as old as human civilization itself. Since early history, man has indulged in ecology in a practical sort of way, knowingly and unknowingly. In primitive societies every individual was required to have an intimate knowledge of his environment for their survival, i.e., about the forces of nature and of plants and animals around him.

Our ancient Indian texts have references to ecological principles. The classical texts of the Vedic period such as the Vedas, the Samhitas, the Brahmanas and the Aranyakas-Upanishads contain many references to ecological concepts.

The Indian treatise on medicine, the Caraka-Samhita and the surgical text Susruta-Samhita, show that people during this period had a good understanding of plant and animal ecology.

These texts contain classification of animals on the basis of habit and habitat, land in terms of nature of soil, climate and vegetation; and description of plants typical to various localities. Caraka- Samhita contains information that air, land, water and seasons were indispensable for life and that polluted air and water were injurious for health.

1.2. ENVIRONMENT

Everything that surrounds or affects an organism during its life time is collectively known as its environment which comprises both living (biotic) and nonliving (abiotic) components.

All organisms (from virus to man) are obligatorily dependent on the environment for food, energy, water, oxygen, shelter and for other needs.

The environment is defined as 'the sum total of living, non-living components; influences and events, surrounding an organism.

1.2.1. Concept of environment

The relationship and interaction between organism and environment are highly complex. No organism can live alone without interacting with other organisms. So each organism has other organisms as a part of its environment. Each and everything with which we interact or which we need for our sustenance forms our environment.

The environment is not static. Both biotic and abiotic factors are in a flux and keeps changing continuously.

Components of Environment	
Abiotic	**Biotic**
Energy	Green plants
Radiation	Non-green plants
Temperature & heat flow	Decomposers
Water	Parasites
Atmospheric gases and wind	Symbionts
Fire	Animals
Gravity	Man
Topography	
Soil	
Geologic substratum	

Do you know?

Diesel engine exhaust fumes can cause cancer in humans and it belong to the same potentially deadly category as asbestos, arsenic and mustard gas - World Health Organization (WHO) (June, 2012).

For instance: Let's take the environment of a fish in the pond.

External environment of fish

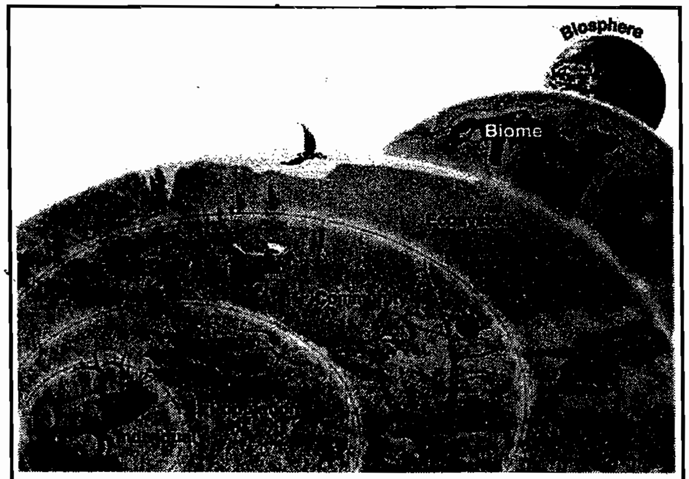
- Its environment consists of abiotic components such as light, temperature, including the water in which nutrients, oxygen, other gases and organic matter are dissolved.
- The biotic environment consists of microscopic organisms called plankton as well as aquatic plants and animals and decomposers.

Internal environment of fish

- It is enclosed by the outer body surface.
- The internal environment is relatively stable as compared to the external environment.
- However, it is not absolutely constant. Injury, illness or excessive stress upsets the internal environment.
- For example, if a marine fish is transferred to a fresh water environment, it will not be able to survive.

1.3. LEVELS OF ORGANISATIONS IN ECOLOGY

The main levels of organisation of ecology are six and are as follows.



Ecological Organisation

1.3.1. Individual

Organism is an individual living being that has the ability to act or function independently. It may be plant, animal, bacterium, fungi, etc. It is a body made up of organs, organelles, or other parts that work together to carry out on the various processes of life.

1.3.2. Population

Population is a group of organisms usually of the same species, occupying a defined area during a specific time.

Population growth rate is the percentage variation between the number of individuals in a population at two different times. Therefore the population growth rate can be positive or negative.

The main factors that make population grow are birth and immigration. The main factors that make population decrease are death and emigration.

The main limiting factors for the growth of a population are abiotic and biotic components.

Population density is the relation between the number of individuals of a population and the area they occupy.

1.3.3. Community

If we look around ourself, we will notice that population of plants and animals seldom occur by themselves. The reason for this is quite obvious. In order to survive, individuals of any one species depend on individuals of different species with which they actively interact in several ways.

For eg: Animals require plants for food and trees for shelter. Plants require animals for pollination, seed dispersal, and soil microorganism to facilitate nutrient supply.

Communities in most instances are named after the dominant plant form (species).

For example: A grassland community is dominated by grasses, though it may contain herbs, shrubs, and trees, alongwith associated animals of different species.

A community is not fixed or rigid; communities may be large or small.

Do you know?

The skies over North India are seasonally filled with a thick soup of aerosol particles all along the southern edge of the Himalayas, Bangladesh and the Bay of Bengal.- NASA research findings.

Types of Community

On the basis of size and degree of relative independence communities may be divided into two types:

(a) Major Community

These are large-sized, well organized and relatively independent. They depend only on the sun's energy from outside and are independent of the inputs and outputs from adjacent communities.

E.g: tropical ever green forest in the North-East

(b) Minor Communities

These are dependent on neighbouring communities and are often called societies. They are secondary aggregations within a major community and are not therefore completely independent units as far as energy and nutrient dynamics are concerned. e.g: A mat of lichen on a cow dung pad.

Structure of a community

In a community the number of species and size of their population vary greatly. A community may have one or several species.

The environmental factors determine the characteristic of the community as well as the pattern of organisation of the members in the community.

The characteristic pattern of the community is termed as structure which is reflected in the roles played by various population, their range, the type of area they inhabit, the diversity of species in the community and the spectrum of interactions between them.

1.3.4. Eco-System

An ecosystem is defined as a structural and functional unit of biosphere consisting of community of living beings and the physical environment, both interacting and exchanging materials between them.

An Ecosystem is a complex set of relationship among the living resources, habitats, and residents of an area. It includes plants, trees, animals, fish, birds, micro-organisms, water, soil, and people.

Ecosystems vary greatly in size and elements but each is a functioning unit of nature. Everything that lives in an ecosystem is dependent on the other species and elements that are also part of that ecological community. If one part of an ecosystem is damaged or disappears, it has an impact on everything else.

When an ecosystem is healthy (i.e. sustainable) it means that all the elements live in balance and are capable of reproducing themselves. Ecosystem can be as small as a single tree or as large as entire forest.

Difference between ecology, environment and ecosystem

For example, let us take Shankar IAS Academy and its students. Let's say that ecology would be the scientific study of student's relationship with the Shankar IAS Academy as a whole. The Shankar IAS Academy being the environment in which the student studies, and the set of circumstances surrounding the student in which environment would be the teachers, books, other students, etc are said to be ecosystem.

Components of Ecosystem

The components of the ecosystem is categorised into abiotic of non-living and biotic of living components. Both the components of ecosystem and environment are same.

1. Abiotic Components

Abiotic components are the inorganic and non-living parts of the world. The abiotic part consists of soil, water, air, and light energy etc. It also involves a large number of chemicals like oxygen, nitrogen etc. and physical processes including volcanoes, earthquakes, floods, forest fires, climates, and weather conditions.

Abiotic factors are the most important determinants of where and how well an organism exists in its environment. Although these factors interact with each other, one single factor can limit the range of an organism.

a) Energy

Energy from the sun is essential for maintenance of life. In the case of plants, the sun directly supplies the necessary energy. Since animals cannot use solar energy directly they obtain it indirectly by eating plants or animals or both. Energy determines the distribution of organisms in the environment.

b) Rainfall

Water is essential for all living beings. Majority of biochemical reactions take place in an aqueous medium. Water helps to regulate body temperature. Further, water bodies form the habitat for many aquatic plants and animals.

c) Temperature

Temperature is a critical factor of the environment which greatly influences survival of organisms. Organisms can tolerate only a certain range of temperature and humidity.

d) Atmosphere

The earth's atmosphere is responsible for creating conditions suitable for the existence of a healthy biosphere on this planet. It is made up of 21% oxygen, 78% nitrogen 0.038% carbon dioxide, and other inert gases (0.93% Argon, Neon etc).

e) Substratum

Land is covered by soil and a wide variety of microbes, protozoa, fungi and small animals (invertebrates) thrive in it. Roots of plants pierce through the soil to tap water and nutrients. Organisms can be terrestrial or aquatic. Terrestrial animals live on land. Aquatic plants, animals and microbes live in fresh water as well as in the sea. Some microbes live even in hot water vents under the sea.

f) Materials:

(i) Organic compound such as proteins, carbohydrates, lipids, humic substances are formed from inorganic compound on decomposition.

(ii) Inorganic compound such as carbon, carbon dioxide, water, sulphur, nitrates, phosphates, and ions of various metals are essential for organisms to survive.

g) Latitude and altitude

Latitude has a strong influence on an area's temperature, resulting in change of climates such as polar, tropical, and temperate. These climates determine different natural biomes.

From sea level to highest peaks, wild life is influenced by altitude. As the altitude increases, the air becomes colder and drier, affecting wild life accordingly.

2. Biotic Components

Biotic components include living organisms comprising plants, animals and microbes and are classified according to their functional attributes into producers and consumers.

a) Primary producers - Autotrophs (self-nourishing)

- Primary producers are basically green plants (and certain bacteria and algae).
- They synthesise carbohydrate from simple inorganic raw materials like carbon dioxide and water in the presence of sunlight by the process of photosynthesis for themselves, and supply indirectly to other non-producers.
- In terrestrial ecosystem, producers are basically herbaceous and woody plants, while in aquatic ecosystem producers are various species of microscopic algae.

b) Consumers – Heterotrophs or phagotrophs (other nourishing)

- Consumers are incapable of producing their own food (photosynthesis).
- They depend on organic food derived from plants, animals or both.
- Consumers can be divided into two broad groups namely micro and macro consumers.

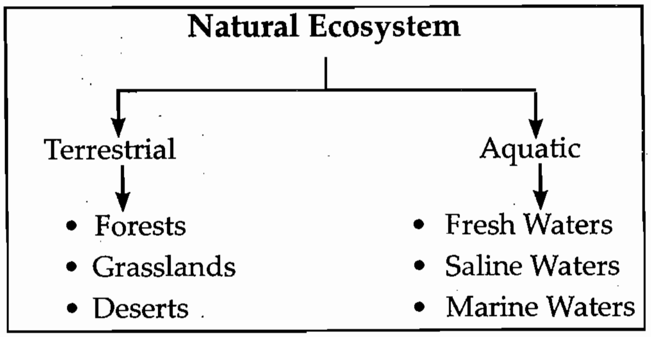
(i) Macro consumers

- They feed on plants or animals or both and are categorised on the basis of their food sources.
- Herbivores are primary consumers which feed mainly on plants e.g. cow, rabbit.
- Secondary consumers feed on primary consumers e.g. wolves.
- Carnivores which feed on secondary consumers are called tertiary consumers e.g. lions which can eat wolves.
- Omnivores are organisms which consume both plants and animals e.g. man.

(ii) Micro consumers - Saprotrophs (decomposers or osmotrophs)

- They are bacteria and fungi which obtain energy and nutrients by decomposing dead organic substances (detritus) of plant and animal origin.
- The products of decomposition such as inorganic nutrients which are released in the ecosystem are reused by producers and thus recycled.
- Earthworm and certain soil organisms (such as nematodes, and arthropods) are detritus feeders and help in the decomposition of organic matter and are called detrivores.

Classification of Eco-system :



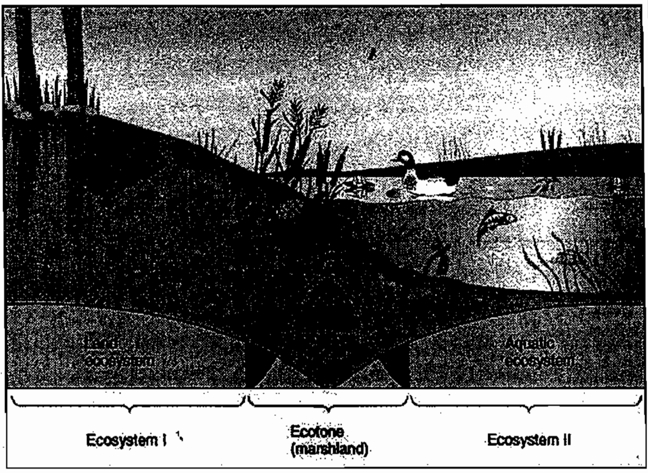
The detailed study of ecosystem will be dealt in the subsequent chapters.

Goods and Services provided by ecosystems include :

- Provision of food, fuel and fibre
- Provision of shelter and building materials
- Purification of air and water
- Detoxification and decomposition of wastes
- Stabilization and moderation of the Earth's climate
- Moderation of floods, droughts, temperature extremes and the forces of wind.
- Generation and renewal of soil fertility, including nutrient cycling.
- Pollination of plants, including many crops Control of pests and diseases
- Maintenance of genetic resources as key inputs to crop varieties and livestock breeds, medicines, and other products
- Cultural and aesthetic benefits

Ecotone

Ecotone is a zone of junction between two or more diverse ecosystems. For e.g. the mangrove forests represent an ecotone between marine and terrestrial ecosystem. Other examples are – grassland, estuary and river bank



Ecotone

Characteristics of Ecotone

- It may be very narrow or quite wide.
- It has the conditions intermediate to the adjacent ecosystems. Hence it is a zone of tension.
- It is linear as it shows progressive increase in species composition of one in coming community and a simultaneous decrease in species of the other out going adjoining community.
- A well developed ecotones contain some organisms which are entirely different from that of the adjoining communities.
- Sometimes the number of species and the population density of some of the species is much greater in this zone than either community. This is called edge effect.

The organisms which occur primarily or most abundantly in this zone are known as edge species. In the terrestrial ecosystems edge effect is especially applicable to birds.

For example the density of birds is greater in the mixed habitat of the ecotone between the forest and the desert.

Niche

A niche is the unique functional role or place of a species in an ecosystem. It is a description of all the biological, physical and chemical factors that a species needs to survive, stay healthy and reproduce.

A niche is unique for a species, which means no two species have exact identical niches. Niche plays an important role in conservation of organisms.

If we have to conserve species in its native habitat we should have knowledge about the niche requirements of the species and should ensure that all requirements of its niche are fulfilled.

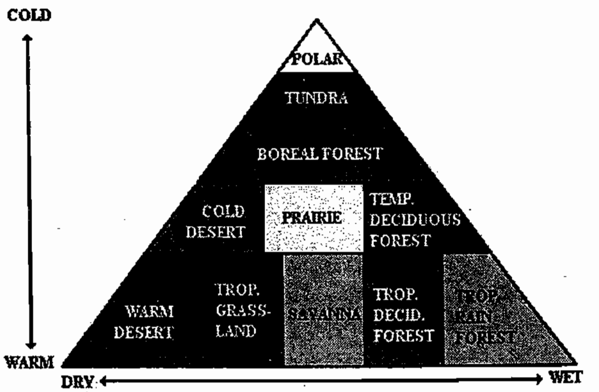
Types of Niche

1. Habitat niche – where it lives
2. Food niche – what is eats or decomposes & what species it competes with
3. Reproductive niche – how and when it reproduces.
4. Physical & chemical niche – temperature, land shape, land slope, humidity & other requirement.

1.3.5. Biome

The terrestrial part of the biosphere is divisible into enormous regions called biomes, which are characterized, by climate, vegetation, animal life and general soil type.

No two biomes are alike. The climate determines the boundaries of a biome and abundance of plants and animals found in each one of them. The most important climatic factors are temperature and precipitation.



BIOME Distribution based on Temperature and Precipitation

S.No.	Name of Biome	Region	Flora and Fauna
1	Tundra	Northern most region adjoining the ice bound poles	Devoid of trees except stunted shrubs in the southern part of tundra biome, ground flora includes lichen, mosses and sedges. The typical animals are reindeer, arctic fox, polar bear, snowy owl, lemming, arctic hare, ptarmigan. Reptiles and amphibians are almost absent.
2	Taiga	Northern Europe, Asia and North America. Moderate temperature than tundra. Also known as boreal forest.	The dominating vegetation is coniferous evergreen mostly spruce, with some pine and firs. The fauna consists of small seed eating birds, hawks, fur bearing carnivores, little mink, elks, puma, Siberian tiger, wolverine, wolves etc.
3	Temperate Deciduous Forest	Extends over Central and Southern Europe, Eastern North America, Western China, Japan, New Zealand etc. Moderate average temperature and abundant rainfall. These are generally the most productive agricultural areas of the earth	The flora includes trees like beech, oak, maple and cherry. Most animals are the familiar vertebrates and invertebrates.
4	Tropical rain forest	Tropical areas in the equatorial regions, which is abound with life. Temperature and rainfall high.	Tropical rainforest covers about 7% of the earth's surface & 40% of the world's plant and animal species. Multiple storey of broad-leafed evergreen tree species are in abundance. Most animals and epiphytic plants are concentrated in the canopy or tree top zones.
5	Savannah	Tropical region: Savannah is most extensive in Africa.	Grasses with scattered trees and fire resisting thorny shrubs. The fauna include a great diversity of grazers and browsers such as antelopes, buffaloes, zebras, elephants and rhinoceros; the carnivores include lion, cheetah, hyena; and mongoose, and many rodents.
6	Grassland	North America, Ukraine, etc . Dominated by grasses. Temperate conditions with rather low rainfall.	Grasses dominate the vegetation. The fauna include large herbivores like bison, antelope, cattle, rodents, prairie dog, wolves, and a rich and diverse array of ground nesting bird.
7	Desert	Continental interiors with very low and sporadic rainfall with low humidity. The days are very hot but nights are cold.	The flora is drought resistance vegetation such as cactus, euphorbias, sagebrush. Fauna : Reptiles, Mammals and birds.

Aquatic Zones

Aquatic systems are not called biomes, however they are divided into distinct life zones, with regions of relatively distinct plant and animal life. The major differences between the various aquatic zones are due to salinity, levels of dissolved nutrients; water temperature, depth of sunlight penetration.

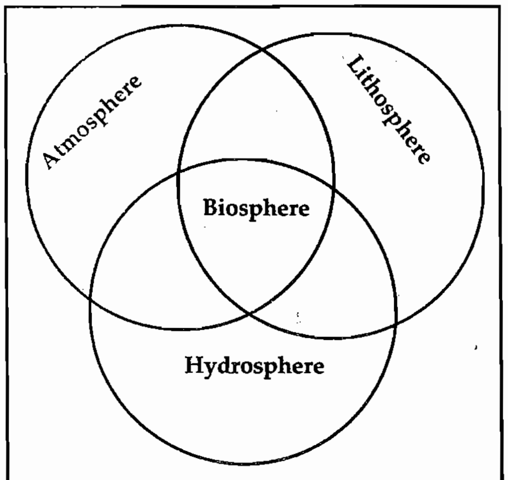
S.No	Aquatic ecosystem	Characteristics
1.	Fresh Water Ecosystem	Fresh water ecosystem are classified as lotic (moving water) or lentic (still or stagnant water). Lotic water system includes freshwater streams, springs, rivulets, creeks, brooks, and rivers. Lentic water bodies include pools, ponds, some swamps, bogs and lakes. They vary considerably in physical, chemical and biological characteristics.
2.	Marine Ecosystem	Nearly three – quarter of earth's surface is covered by ocean with an average depth of 3,750 m and with salinity 35 ppt, (parts per thousand), about 90 per cent of which is sodium chloride.
3.	Estuaries	Coastal bays, river mouths and tidal marshes form the estuaries. In estuaries, fresh water from rivers meet ocean water and the two are mixed by action of tides. Estuaries are highly productive as compared to the adjacent river or sea.

1.3.6. Biosphere

Biosphere is a part of the earth where life can exist. Biosphere represents a highly integrated and interacting zone comprising of atmosphere (air), hydrosphere (water) and lithosphere (land).

It is a narrow layer around the surface of the earth. If we visualise the earth to be the size of an apple the biosphere would be as thick as its skin.

Life in the biosphere is abundant between 200 metres (660 feet) below the surface of the ocean and about 6,000 metres (20,000 feet) above sea level.



Biosphere

Biosphere is absent at extremes of the North and South poles, the highest mountains and the deepest oceans, since existing hostile conditions there do not support life. Occasionally spores of fungi and bacteria do occur at great height beyond 8,000 metres, but they are not metabolically active, and hence represent only dormant life.

The energy required for the life within the biosphere comes from the sun. The nutrients necessary for living organisms come from air, water and soil. The same chemicals are recycled over and over again for life to continue.

Living organisms are not uniformly distributed throughout the biosphere. Only a few organisms live in the polar regions, while the tropical rain forests have an exceedingly rich diversity of plants and animals.

◆◆◆◆◆◆

CHAPTER - 2

FUNCTIONS OF AN ECOSYSTEM

The function of an ecosystem is a broad, vast and complete dynamic system. It can be studied under the following three heads.

- Energy flow
- Nutrient cycling (biogeochemical cycles)
- Ecological succession or ecosystem development

2.1 ENERGY FLOW

Energy is the basic force responsible for all metabolic activities. The flow of energy from producer to top consumers is called energy flow which is unidirectional.

The study of Trophic level interaction in an ecosystem gives an idea about the energy flow through the ecosystem.

2.1.1. Trophic level interaction

Trophic level interaction deals with how the members of an ecosystem are connected based on nutritional needs.

Trophic levels (Trophe = nourishment)		
I	Autotrophs	Green plants (producers)
II	Heterotrophs	Herbivore (primary consumers)
III	Heterotrophs	Carnivores (secondary consumers)
IV	Heterotrophs	Carnivore (tertiary consumers)
V	Heterotrophs	Top carnivores (Quarternary consumers)

Energy flows through the trophic levels: from producers to subsequent trophic levels. This energy always flows from lower (producer) to higher (herbivore, carnivore etc.) trophic level. It never flows in the reverse direction that is from carnivores to herbivores to producers.

There is a loss of some energy in the form of unusable heat at each trophic level so that energy level decreases from the first trophic level upwards.

As a result there are usually four or five trophic levels and seldom more than six as beyond that very little energy is left to support any organism. Trophic levels are numbered according to the steps an organism is away from the source of food or energy, that is the producer.

The trophic level interaction involves three concepts namely :-

1. Food Chain
2. Food Web
3. Ecological Pyramids

2.2. FOOD CHAIN

Organisms in the ecosystem are related to each other through feeding mechanism or trophic levels, i.e. one organism becomes food for the other. A sequence of organisms that feed on one another, form a food chain. A food chain starts with producers and ends with top carnivores.

The sequence of eaten and being eaten, produces transfer of food energy and it is known as food chain. The plant converts solar energy into protoplasm by photosynthesis.

Small herbivores consume the vegetable matter and convert them into animal matter. These herbivores are eaten by large carnivores.

Do you know?

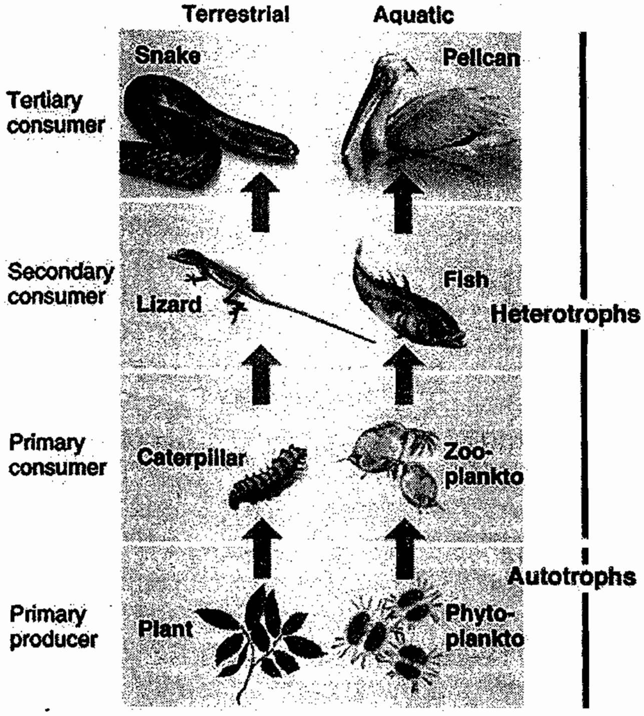
Bear hibernation is different than most hibernating animals. True hibernation (like we see in ground squirrels) involves a drastic drop in body temperature but the hibernating animal will awaken occasionally to eat and defecate before resuming hibernation. When a bear 'hibernates' it is really in a deep sleep. It's body temperature drops but not drastically and it does not wake up. The one exception is that a mother bear will wake up to give birth in January or February. Since food is scarce in the winter bears figure that if you can't eat you might as well sleep. Bears like the Asiatic Bear live in warmer climates where food is readily available all year long and there is no need to hibernate.

2.2.1. Types of Food Chains

In nature, two main types of food chains have been distinguished:

i) Grazing food chain

The consumers which start the food chain, utilising the plant or plant part as their food, constitute the grazing food chain. This food chain begins from green plants at the base and the primary consumer is herbivore.



Grazing Food Chain

For example, In terestrial ecosystem, grass is eaten up by caterpillar, which is eaten by lizard and lizard is eaten by snake.

In Aquatic ecosystem phytoplanktons (primary producers) is eaten by zoo planktons which is eaten by fishes and fishes are eaten by pelicans.

ii) Detritus food chain

The food chain starts from dead organic matter of decaying animals and plant bodies to the micro-organisms and then to detritus feeding organism called detrivores or decomposer and to other predators.

Litter → Earthworms → Chicken → Hawk

Detritus food chain

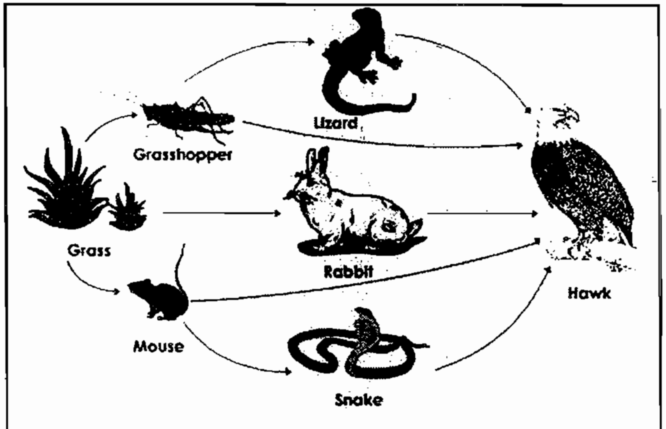
The distinction between these two food chains is the source of energy for the first level consumers. In the grazing food chain the primary source of energy is living plant biomass while in the detritus food chain the source of energy is dead organic matter or detritus. The two food chains are linked. The initial energy source for detritus food chain is the waste materials and dead organic matter from the grazing food chain.

2.3. FOOD WEB

A food chain represents only one part of the food or energy flow through an ecosystem and implies a simple, isolated relationship, which seldom occurs in the ecosystems.

An ecosystem may consist of several interrelated food chains. More typically, the same food resource is part of more than one chain, especially when that resource is at the lower trophic levels.

"A food web illustrates, all possible transfers of energy and nutrients among the organisms in an ecosystem, whereas a food chain traces only one pathway of the food".



- A Food Web in a Grassland Ecosystem With Five Possible Food Chains

If any of the intermediate food chain is removed, the succeeding links of the chain will be affected largely. The food web provides more than one alternative for food to most of the organisms in an ecosystem and therefore increases their chance of survival.

For example, grasses may serve food for rabbit or grasshopper or goat or cow. Similarly a herbivore may be food source for many different carnivorous species.

Also food availability and preferences of food of the organisms may shift seasonally e.g. we eat watermelon in summer and peaches in the winter. Thus there are interconnected networks of feeding relationships that take the form of food webs.

Do you know?

Dolphins, Porpoises and whales are called cetaceans. A cetacean is a creature belonging to a group of water living mammals that have no hind limbs and a blowhole for breathing. They are not fish!

2.4. ECOLOGICAL PYRAMIDS

The steps of trophic levels expressed in a diagrammatic way are referred as ecological pyramids. The food producer forms the base of the pyramid and the top carnivore forms the tip. Other consumer trophic levels are in between.

The pyramid consists of a number of horizontal bars depicting specific trophic levels which are arranged sequentially from primary producer level through herbivore, carnivore onwards. The length of each bar represents the total number of individuals at each trophic level in an ecosystem.

The number, biomass and energy of organisms gradually decrease with each step from the producer level to the consumer level and the diagrammatic representation assumes a pyramid shape.

The ecological pyramids are of three categories.

- 1. Pyramid of numbers,
- 2. Pyramid of biomass, and
- 3. Pyramid of energy or productivity.

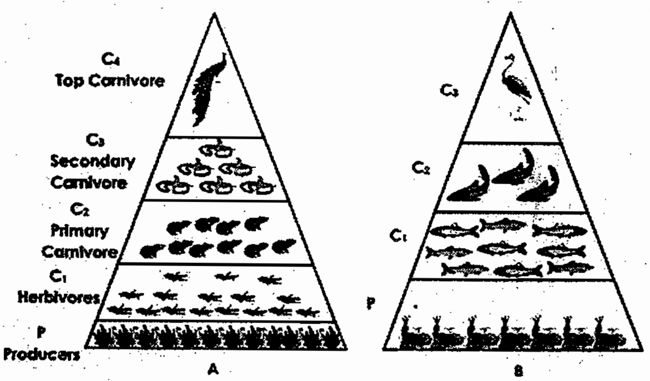
2.4.1. Pyramid of Numbers

This deals with the relationship between the numbers of primary producers and consumers of different levels. It is a graphic representation of the total number of individuals of different species, belonging to each trophic level in an ecosystem.

Depending upon the size and biomass, the pyramid of numbers may not always be upright, and may even be completely inverted.

(a) Pyramid of numbers - upright

- In this pyramid, the number of individuals is decreased from lower level to higher trophic level.
- This type of pyramid can be seen in grassland ecosystem.

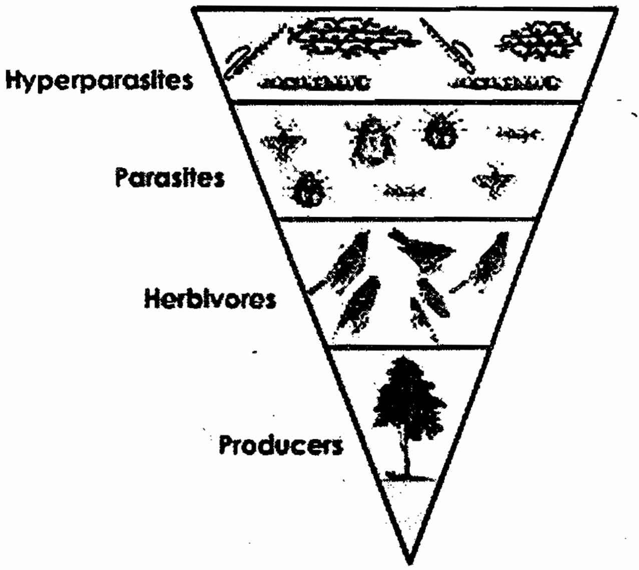


Upright Pyramids of Numbers. (A) In a Grass Land (B) In a Pond

- The grasses occupy the lowest trophic level (base) because of their abundance.
- The next higher trophic level is primary consumer - herbivore (example – grasshopper).
- The individual number of grasshopper is less than that of grass. The next energy level is primary carnivore (example – rat).
- The number of rats are less than grasshopper, because, they feed on grasshopper. The next higher trophic level is secondary carnivore (example – snakes). They feed on rats.
- The next higher trophic level is the top carnivore. (Ex.Hawk).
- With each higher trophic level, the number of individual decreases.

(b) Pyramid of numbers - inverted

- In this pyramid, the number of individuals is increased from lower level to higher trophic level.



Inverted Pyramid of Numbers

- A count in a forest would have a small number of large producers, for e.g. few number of big trees.
- This is because the tree (primary producer) being few in number and would represent the base of the pyramid and the dependent herbivores (Example - Birds) in the next higher trophic level and it is followed by parasites in the next trophic level. Hyper parasites being at higher trophic level represents higher in number.
- And the resulting pyramid is in inverted shape. A pyramid of numbers does not take into account the fact that the size of organisms being counted in each trophic level can vary.

- It is very difficult to count all the organisms, in a pyramid of numbers and so the pyramid of number does not completely define the trophic structure for an ecosystem.

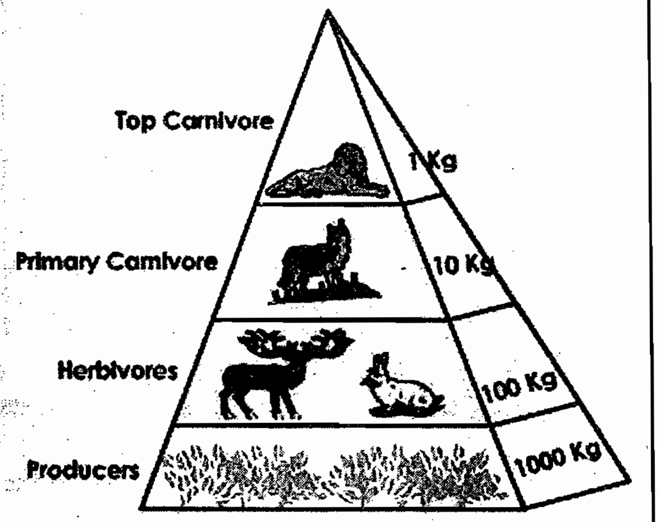
2.4.2. Pyramid of Biomass

In order to overcome the shortcomings of pyramid of numbers, the pyramid of biomass is used. In this approach individuals in each trophic level are weighed instead of being counted. This gives us a pyramid of biomass, i.e., the total dry weight of all organisms at each trophic level at a particular time.

Pyramid of biomass is usually determined by collecting all organisms occupying each trophic level separately and measuring their dry weight. This overcomes the size difference problem because all kinds of organisms at a trophic level are weighed. Biomass is measured in g/m2.

(a) Upward pyramid

For most ecosystems on land, the pyramid of biomass has a large base of primary producers with a smaller trophic level perched on top.

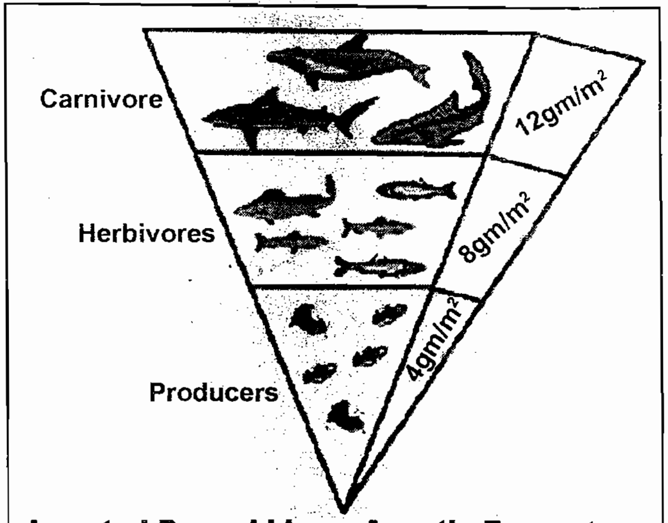


Upright Pyramid of Biomass

The biomass of producers (autotrophs) is at the maximum. The biomass of next trophic level i.e primary consumers is less than the producers. The biomass of next higher trophic level i.e secondary consumers is less than the primary consumers. The top, high trophic level has very less amount of biomass.

(b) Inverted pyramid

In contrast, in many aquatic ecosystems, the pyramid of biomass may assume an inverted form.



Inverted Pyramid in an Aquatic Ecosystem

This is because the producers are tiny phytoplanktons that grow and reproduce rapidly. Here, the pyramid of biomass has a small base, with the consumer biomass at any instant actually exceeding the producer biomass and the pyramid assumes inverted shape.

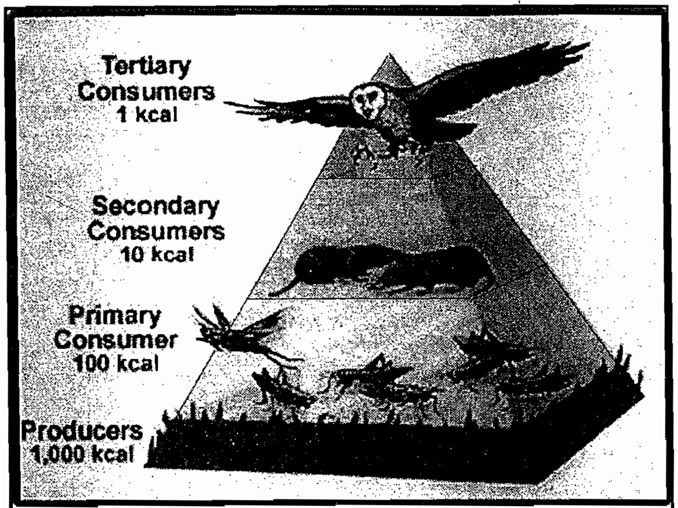
2.4.3. Pyramid of Energy

To compare the functional roles of the trophic levels in an ecosystem, an energy pyramid is most suitable. An energy pyramid, reflects the laws of thermodynamics, with conversion of solar energy to chemical energy and heat energy at each trophic level and with loss of energy being depicted at each transfer to another trophic level. Hence the pyramid is always upward, with a large energy base at the bottom.

Let us explain this with an example. Suppose an ecosystem receives 1000 calories of light energy in a given day. Most of the energy is not absorbed; some is reflected back to space; of the energy absorbed only a small portion is utilised by green plants, out of which the plant uses up some for respiration and of the 1000 calories, therefore only 100 calories are stored as energy rich materials.

Do you know?

All snakes smell with their tongues. When a snake sticks out its tongue it smells its surroundings. The moist tongue collects scents and small organisms from whatever it touches and from the air around it. When the tongue goes back into the mouth the forks touch a special sensory spot called the Jacobson's organ on the roof of the mouth and tells the snake what it smells. Snakes have a small notch in their lips that they can stick their tongues through so they don't need to open their mouths. Some snakes can smell with their noses.



Pyramid of energy

Now suppose an animal, say a deer, eats the plant containing 100 cal of food energy. The deer uses some of it for its own metabolism and stores only 10 cal as food energy. A lion that eats the deer gets an even smaller amount of energy. Thus usable energy decreases from sunlight to producer to herbivore to carnivore. Therefore, the energy pyramid will always be upright.

Energy pyramid concept helps to explain the phenomenon of biological magnification- the tendency for toxic substances to increase in concentration progressively at higher levels of the food chain.

2.5 POLLUTANTS AND TROPHIC LEVEL

Pollutants especially nondegradable ones move through the various trophic levels in an ecosystem.

Nondegradabale pollutants mean materials, which cannot be metabolized by the living organisms.

Example: chlorinated hydrocarbons.

We are concerned about these phenomena because, together they enable even small concentrations of chemicals in the environment to find their way into organisms in high enough dosages to cause problems.

Movement of these pollutants involves two main processes:

i) Bioaccumulation

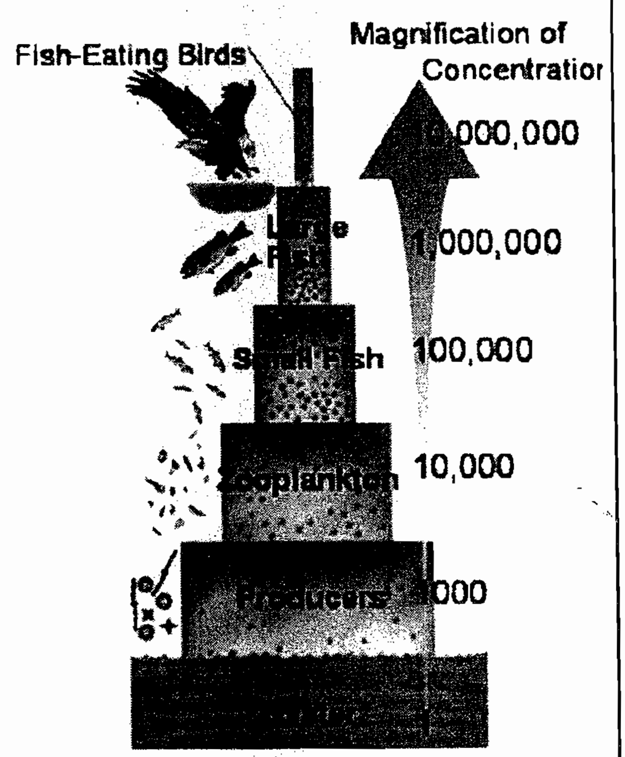
ii) Biomagnification.

2.5.1. Bioaccumulation

- It refers to how pollutants enter a food chain.
- In bioaccumulation there is an increase in concentration of a pollutant from the environment to the first organism in a food chain.

2.5.2. Biomagnification

- Biomagnification refers to the tendency of pollutants to concentrate as they move from one trophic level to the next.
- Thus in biomagnification there is an increase in concentration of a pollutant from one link in a food chain to another.



Biomagnification

In order for biomagnification to occur, the pollutant must be: long-lived, mobile, soluble in fats, biologically active.

If a pollutant is short-lived, it will be broken down before it can become dangerous. If it is not mobile, it will stay in one place and is unlikely to be taken up by organisms. If the pollutant is soluble in water, it will be excreted by the organism. Pollutants that dissolve in fats, however, may be retained for a long time.

It is traditional to measure the amount of pollutants in fatty tissues of organisms such as fish. In mammals, we often test the milk produced by females, since the milk has a lot of fat in it are often more susceptible to damage from toxins (poisons). If a pollutant is not active biologically, it may biomagnify, but we really don't worry about it much, since it probably won't cause any problems Examples : DDT.

2.6. BIOTIC INTERACTION

- Organisms living in this earth are interlinked to each other in one way or other. The interaction between the organisms is fundamental for its survival and functioning of ecosystem as a whole.

Biotic Interaction			
S.No.	**Type**	**Spices 1**	**Species 2**
1.	Mutualism	(+)	(+)
2.	Commensalism	(+)	(0)
3.	Competition	(–)	(–)
4.	Predation	(+)	(–)
5.	Parasitism	(+)	(–)
6.	Amensalism	(–)	(0)
7.	Neutralism	(0)	(0)
(+) Benefited		(–) Harmed	
(0) Neither Benefited nor harmed.			

2.6.1. Types of biotic interaction

- **Mutualism:** both species benefit.

  Example: in pollination mutualisms, the pollinator gets food (pollen, nectar), and the plant has its pollen transferred to other flowers for cross-fertilization (reproduction).
- **Commensalism:** one species benefits, the other is unaffected.

  Example: cow dung provides food and shelter to dung beetles. The beetles have no effect on the cows.
- **Competition:** both species are harmed by the interaction.

  Example: if two species eat the same food, and there isn't enough for both, both may have access to less food than they would if alone. They both suffer a shortage of food
- **Predation and parasitism:** one species benefits, the other is harmed.

  Example : predation—one fish kills and eats parasitism: tick gains benefit by sucking blood; host is harmed by losing blood.
- **Amensalism :** One species is harmed, the other is unaffected.

  Example: A large tree shades a small plant, retarding the growth of the small plant. The small plant has no effect on the large tree.
- **Neutralism :** There is no net benefit or harm to either species. Perhaps in some interspecific interactions, the costs and benefits experienced by each partner are exactly the same so that they sum to zero. It is not clear how often this happens in nature. Neutralism is also sometimes described as the relationship between two species inhabiting the same space and using the same resources, but that have no effect on each other. In this case, one could argue that they aren't interacting at all.

2.7. BIOGEO CHEMICAL CYCLE

The living world depends upon the energy flow and the nutrients circulation that occurs through ecosystem. Both influence the abundance of organisms, the metabolic rate at which they live, and the complexity of the ecosystem.

Energy flows through ecosystems enabling the organisms to perform various kinds of work and this energy is ultimately lost as heat forever in terms of the usefulness of the system. On the other hand, nutrients of food matter never get used up. They can be recycled again and again indefinitely.

For e.g. when we breathe we may be inhaling several million atoms of elements that may have been inhaled by our ancestors or other organisms.

Carbon, hydrogen, oxygen, nitrogen and phosphorus as elements and compounds make up 97% of the mass of our bodies and are more than 95% of the mass of all living organisms. In addition to these about 15 to 25 other elements are needed in some form for the survival and good health of plants and animals.

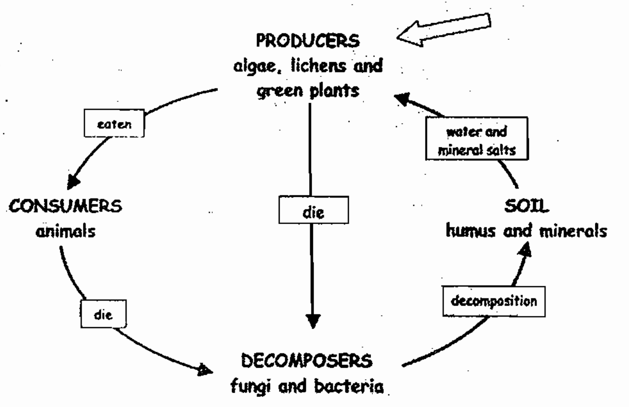
These elements or mineral nutrients are always in circulation moving from non-living to living and then back to the non-living components of the ecosystem in a more or less circular fashion. This circular fashion is known as biogeochemical cycling (bio for living; geo for atmosphere).

2.7.1. Nutrient Cycling

The nutrient cycle is a concept that describes how nutrients move from the physical environment to the living organisms, and subsequently recycled back to the physical environment.

This movement of nutrients from the environment into plants and animals and again back to the environment is essential for life and it is the vital function of the ecology of any region. In any particular environment, to maintain its organism in a sustained manner, the nutrient cycle must be kept balanced and stable.

Nutrient cycling is typically studied in terms of specific nutrients, with each nutrient in an environment having its own particular pattern of cycling. Among the most important nutrient cycles are the carbon nutrient cycle and the nitrogen nutrient cycle. Both of these cycles make up an essential part of the overall soil nutrient cycle. There are many other nutrient cycles that are important in ecology, including a large number of trace mineral nutrient cycles.



Nutrient cycling

Types of Nutrient Cycle

- Based on the replacement period a nutrient cycle is referred to as Perfect or Imperfect cycle.
- A perfect nutrient cycle is one in which nutrients are replaced as fast as they are utilised. Most gaseous cycles are generally considered as perfect cycles.
- In contrast sedimentary cycles are considered relatively imperfect, as some nutrients are lost from the cycle and get locked into sediments and so become unavailable for immediate cycling.
- Based on the nature of the reservoir, there are two types of cycles namely Gaseous and sedimentary cycle
- Gaseous Cycle – where the reservoir is the atmosphere or the hydrosphere, and
- Sedimentary Cycle – where the reservoir is the earth's crust.

Do you know?

Spiders can't chew or swallow inject their prey with poison using their fangs. The poison turns the insides of insect to a watery goop and the spider just sucks it up.

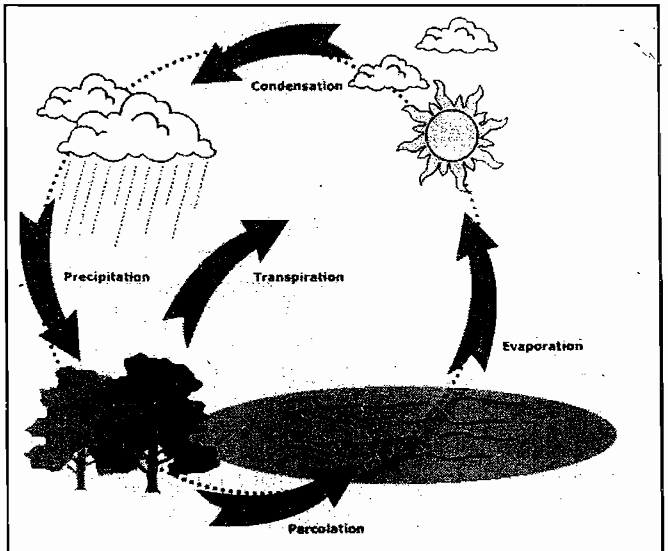
2.7.2. Gaseous Cycles

Let us first study some of the most important gaseous cycles; namely – water, carbon and nitrogen.

(a) Water Cycle (Hydrologic)

Water as an important ecological factor determines the structure and function of the ecosystem. Cycling of all other nutrients is also dependent upon water as it provides their transportation during the various steps. It acts as a solvent medium for their uptake of nutrients by organisms.

The hydrologic cycle is the continuous circulation of water in the Earth-atmosphere system which is driven by solar energy. Water on our planet is stored in major reservoirs like atmosphere, oceans, lakes, rivers, soils, glaciers, snowfields, and groundwater. Water moves from one reservoir to another by the processes of evaporation, transpiration, condensation, precipitation, deposition, runoff, infiltration, and groundwater flow.

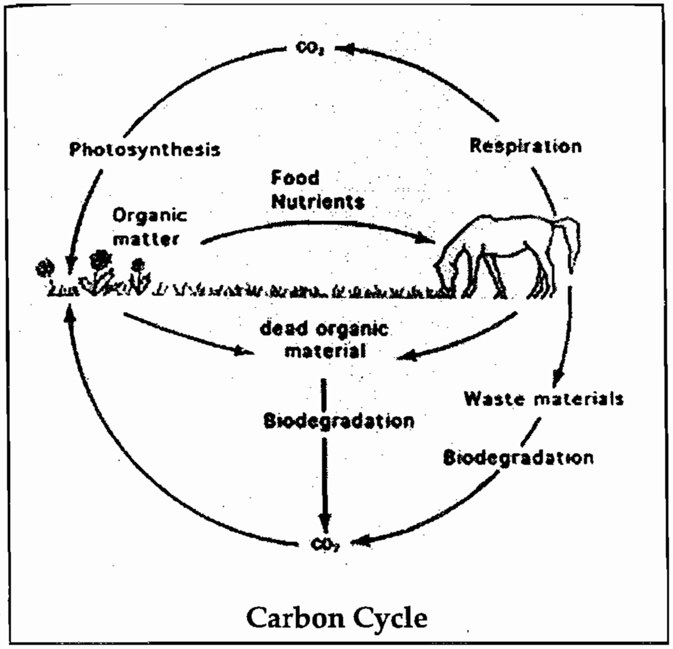


Water Cycle

(b) The Carbon Cycle

Carbon is a minor constituent of the atmosphere as compared to oxygen and nitrogen. However, without carbon dioxide life could not exist, because it is vital for the production of carbohydrates through photosynthesis by plants. It is the element that anchors all organic substances from coal and oil to DNA (deoxyribonucleic acid: the compound that carries genetic information).

Carbon is present in the atmosphere, mainly in the form of carbon dioxide (CO_2). Carbon cycle involves a continuous exchange of carbon between the atmosphere and organisms. Carbon from the atmosphere moves to green plants by the process of photosynthesis, and then to animals. By process of respiration and decomposition of dead organic matter it returns back to atmosphere. It is usually a short term cycle.


CO_2
Photosynthesis
Respiration
Food Nutrients
Organic matter
dead organic material
Waste materials
Biodegradation
Biodegradation
CO_2

Carbon Cycle

Some carbon also enters a long term cycle. It accumulates as un-decomposed organic matter in the peaty layers of marshy soil or as insoluble carbonates in bottom sediments of aquatic systems which take a long time to be released.

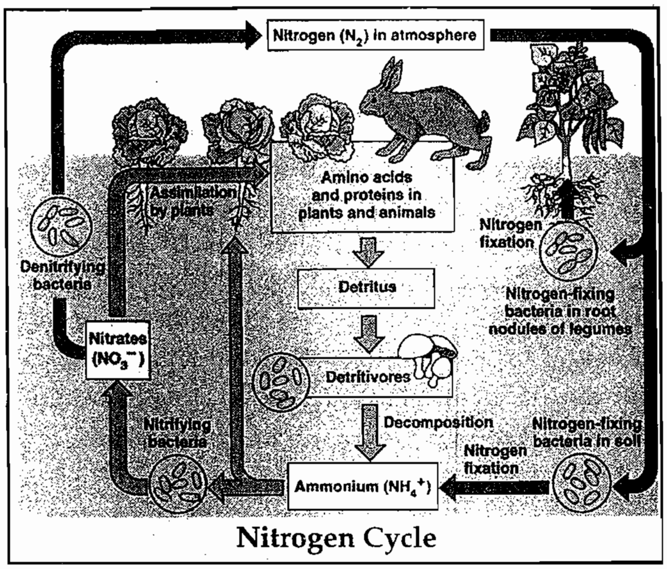
In deep oceans such carbon can remained buried for millions of years till geological movement may lift these rocks above sea level. These rocks may be exposed to erosion, releasing their carbon dioxide, carbonates and bicarbonates into streams and rivers.

Fossil fuels such as coals, oil and natural gas etc. are organic compounds that were buried before they could be decomposed and were subsequently transformed by time and geological processes into fossil fuels. When they are burned the carbon stored in them is released back into the atmosphere as carbon-dioxide.

(c) The Nitrogen Cycle

Nitrogen is an essential constituent of protein and is a basic building block of all living tissue. It constitutes nearly 16% by weight of all the proteins.

There is an inexhaustible supply of nitrogen in the atmosphere but the elemental form cannot be used directly by most of the living organisms. Nitrogen needs to be 'fixed', that is, converted to ammonia, nitrites or nitrates, before it can be taken up by plants.


Nitrogen (N_2) in atmosphere
Assimilation by plants
Amino acids and proteins in plants and animals
Nitrogen fixation
Denitrifying bacteria
Detritus
Nitrogen-fixing bacteria in root nodules of legumes
Nitrates (NO_3^-)
Detritivores
Nitrifying bacteria
Decomposition
Nitrogen fixation
Nitrogen-fixing bacteria in soil
Ammonium (NH_4^+)

Nitrogen Cycle

Nitrogen fixation on earth is accomplished in three different ways:

(i) By microorganisms (bacteria and blue-green algae)

(ii) By man using industrial processes (fertilizer factories) and

(iii) To a limited extent by atmospheric phenomenon such as thunder and lighting

> The amount of Nitrogen fixed by man through industrial process has far exceeded the amount fixed by the Natural Cycle. As a result Nitrogen has become a pollutant which can disrupt the balance of nitrogen. It may lead to Acid rain, Eutrophication and Harmful Algal Blooms.

Certain microorganisms are capable of fixing atmospheric nitrogen into ammonium ions. These include free living nitrifying bacteria (e.g. aerobic Azotobacter and anaerobic Clostridium) and symbiotic nitrifying bacteria living in association with leguminous plants and symbiotic bacteria living in non leguminous root nodule plants (e.g. Rhizobium) as well as blue green algae (e.g. Anabaena, Spirulina).

Ammonium ions can be directly taken up as a source of nitrogen by some plants, or are oxidized to nitrites or nitrates by two groups of specialised bacteria: Nitrosomonas bacteria promote transformation of ammonia into nitrite. Nitrite is then further transformed into nitrate by the bacteria Nitrobacter.

The nitrates synthesised by bacteria in the soil are taken up by plants and converted into amino acids, which are the building blocks of proteins. These then go through higher trophic levels of the ecosystem. During excretion and upon the death of all organisms nitrogen is returned to the soil in the form of ammonia.

Certain quantity of soil nitrates, being highly soluble in water, is lost to the system by being transported away by surface run-off or ground water. In the soil as well as oceans there are special denitrifying bacteria (e.g. Pseudomonas), which convert the nitrates/nitrites to elemental nitrogen. This nitrogen escapes into the atmosphere, thus completing the cycle.

The periodic thunderstorms convert the gaseous nitrogen in the atmosphere to ammonia and nitrates which eventually reach the earth's surface through precipitation and then into the soil to be utilized by plants.

Do you know?

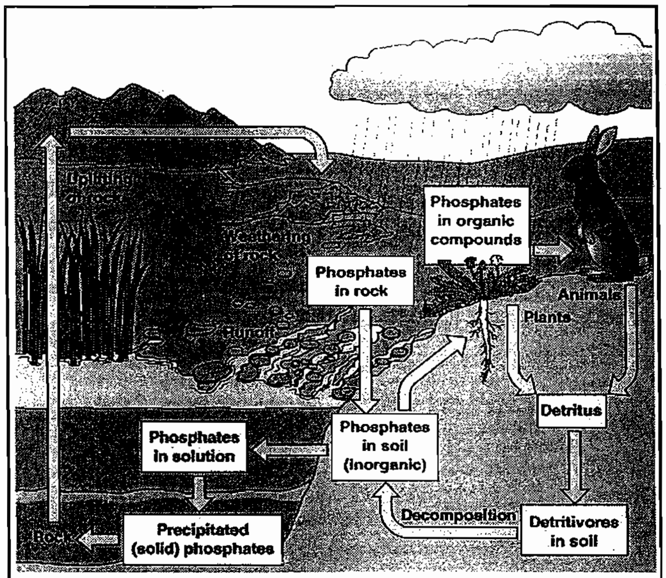
Pythons are constrictors, which mean that they will 'squeeze' the life out of their prey. They coil themselves around their prey and with each breathe the creature takes the snake will squeeze a little tighter until they stop breathing completely. Once the heart stops the prey is swallowed whole. The entire animal is digested in the snake's stomach except for fur or feathers.

2.7.3. Sedimentary Cycle

Phosphorus, calcium and magnesium circulate by means of the sedimentary cycle. The element involved in the sedimentary cycle normally does not cycle through the atmosphere but follows a basic pattern of flow through erosion, sedimentation, mountain building, volcanic activity and biological transport through the excreta of marine birds.

(a) Phosphorus Cycle

Phosphorus plays a central role in aquatic ecosystems and water quality. Unlike carbon and nitrogen, which come primarily from the atmosphere, phosphorus occurs in large amounts as a mineral in phosphate rocks and enters the cycle from erosion and mining activities. This is the nutrient considered to be the main cause of excessive growth of rooted and free-floating microscopic plants in lakes.



Phosphorous cycle

The main storage for phosphorus is in the earth's crust. On land phosphorus is usually found in the form of phosphates. By the process of weathering and erosion phosphates enter rivers and streams that transport them to the ocean.

In the ocean once the phosphorus accumulates on continental shelves in the form of insoluble deposits. After millions of years, the crustal plates rise from the sea floor and expose the phosphates on land. After more time, weathering will release them from rock and the cycle's geochemical phase begins again.

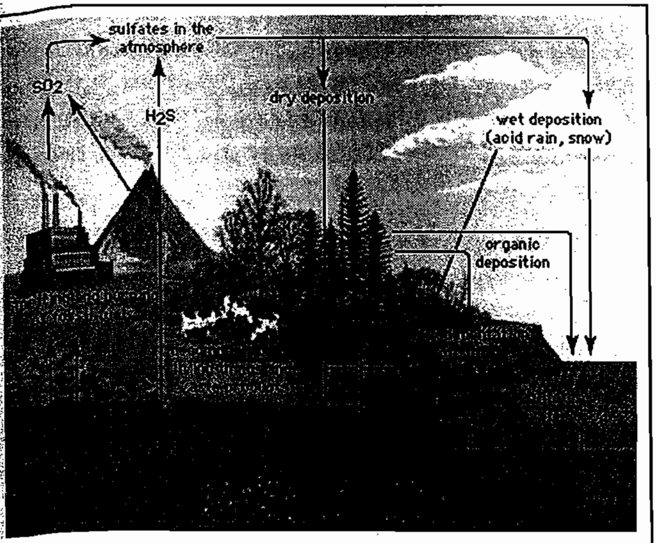
(b) Sulphur Cycle

The sulphur reservoir is in the soil and sediments where it is locked in organic (coal, oil and peat) and inorganic deposits (pyrite rock and sulphur rock) in the form of sulphates, sulphides and organic sulphur.

It is released by weathering of rocks, erosional runoff and decomposition of organic matter and is carried to terrestrial and aquatic ecosystems in salt solution.

The sulphur cycle is mostly sedimentary except two of its compounds hydrogen sulphide (H_2S) and sulphur dioxide (SO_2) add a gaseous component to its normal sedimentary cycle.

Sulphur enters the atmosphere from several sources like volcanic eruptions, combustion of fossil fuels, from surface of ocean and from gases released by decomposition. Atmospheric hydrogen sulphide also gets oxidised into sulphur dioxide. Atmospheric sulphur dioxide is carried back to the earth after being dissolved in rainwater as weak sulphuric acid.



Sulphur Cycle

Whatever the source, sulphur in the form of sulphates is take up by plants and incorporated through a series of metabolic processes into sulphur bearing amino acid which is incorporated in the proteins of autotroph tissues. It then passes through the grazing food chain.

Sulphur bound in living organism is carried back to the soil, to the bottom of ponds and lakes and seas through excretion and decomposition of dead organic material.

The Bio-geochemical cycles discussed here are only a few of the many cycles present in the ecosystem. These cycles usually do not operate independently but interact with each other at some point or the other.

Do you know?

Fur-picking', the universal habit among the apes and monkeys is not a hunt for lice or fleas. They are naturally remarkably free from these vermin. On the contrary it is a means of social communication between members of the troop (a group of monkeys) and to develop strong social bond.

2.8. SUCCESSION

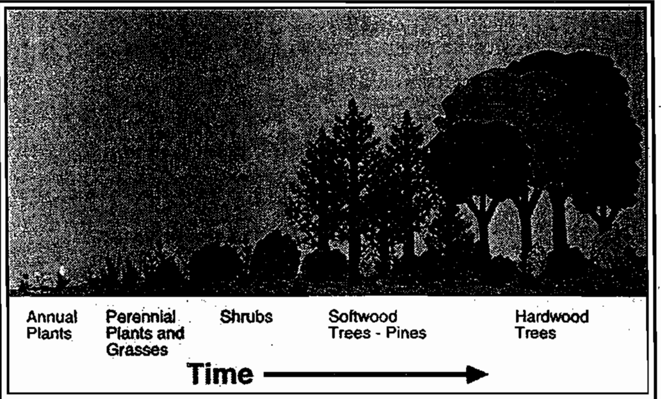
Succession is a universal process of directional change in vegetation, on an ecological time scale.

Succession occurs when a series of communities replace one another due to large scale destruction either natural or manmade. This process continues - one community replacing another community, until a stable, mature community develops.

Succession is a progressive series of changes which leads to the establishment of a relatively stable climax community.

The first plant to colonise an area is called the pioneer community. The final stage of succession is called the climax community. The stage leading to the climax community are called successional stages or seres.

Succession is characterised by the following: increased productivity, the shift of nutrients from' the reservoirs, increased diversity of organisms with increased niche development, and a gradual increase in the complexity of food webs.



Ecological Succession

2.8.1. Primary Succession

In primary succession on a terrestrial site the new site is first colonized by a few hardy pioneer species that are often microbes, lichens and mosses. The pioneers over a few generations alter the habitat conditions by their growth and development.

These new conditions may be conducive to the establishment of additional organisms that may subsequently arrive at the site. The pioneers through their death any decay leave patches of organic matter in which small animals can live.

The organic matter produced by these pioneer species produce organic acids during decomposition that dissolve and etch the substratum releasing nutrients to the substratum. Organic debris accumulates in pockets and crevices, providing soil in which seeds can become lodged and grow.

As the community of organisms continues to develop, it becomes more diverse and competition increases, but at the same time new niche opportunities develops.

The pioneer species disappear as the habitat conditions change and invasion of new species progresses, leading to the replacement of the preceding community.

2.8.1. Secondary Succession

Secondary succession occurs when plants recognize an area in which the climax community has been disturbed.

Secondary succession is the sequential development of biotic communities after the complete or partial destruction of the existing community. A mature or intermediate community may be destroyed by natural events such as floods, droughts, fires, or storms or by human interventions such as deforestation, agriculture, overgrazing, etc

This abandoned farmland is first invaded by hardy species of grasses that can survive in bare, sun-baked soil. These grasses may be soon joined by tall grasses and herbaceous plants. These dominate the ecosystem for some years along with mice, rabbits, insects and seed-eating birds.

Eventually, some trees come up in this area, seeds of which may be brought by wind or animals. And over the years, a forest community develops. Thus an abandoned farmland over a period becomes dominated by trees and is transformed into a forest

The differences between primary and secondary succession, the secondary succession starts on a well developed soil already formed at the site. Thus secondary succession is relatively faster as compared to primary succession which may often require hundreds of years.

2.8.2. Autogenic and Allogenic Succession

When succession is brought about by living inhabitants of that community itself, the process is called autogenic succession, while change brought about by outside forces is known as allogenic succession.

2.8.3. Autotrophic and Heterotrophic succession

Succession in which, initially the green plants are much greater is quantity is known as autotrophic succession; and the ones in which the heterotrophs are greater in quantity is known as heterotrophic succession.

Succession would occur faster in area existing in the middle of the large continent. This is because, here all propagules or seeds of plants belonging to the different seres would reach much faster, establish and ultimately result in climax community.

◆◆◆◆◆◆

CHAPTER - 3

TERRESTRIAL ECOSYSTEMS

The interrelations between organisms and environment on the land constitute "Terrestrial Ecology". Due to variation in the topographic features of valleys, mountains and slopes, certain differences occur. These differences are reflected in both the material and biotic diversities. Altitudinal and latitudinal variations cause shifts and differences in the climatic patterns. Due to varied climate, the plant and animal life existing in different terrestrial areas vary which result in differentiation of ecosystem as segments within the large biosphere. The most important limiting factors of the terrestrial ecosystems are moisture and temperature.

3.1. TUNDRA

The word tundra means a "barren land" since they are found where environmental conditions are very severe. There are two types of tundra- arctic and alpine.

- Distribution: Arctic tundra extends as a continuous belt below the polar ice cap and above the tree line in the northern hemisphere. It occupies the northern fringe of Canada, Alaska, European Russia, Siberia and island group of Arctic Ocean. On the south pole, tundra is very small since most of it is covered by ocean .

Alpine tundra occurs at high mountains above the tree line. Since mountains are found at all latitudes therefore alpine tundra shows day and night temperature variations.

- Flora and fauna: Typical vegetation of arctic tundra is cotton grass, sedges, dwarf heath, willows, birches and lichens. Animals of tundra are reindeer, musk ox, arctic hare, caribous, lemmings and squirrel.

Most of them have long life e.g. Salix arctica (i.e) arctic willow has a life span of 150 to 300 years. They are protected from chillness by the presence of thick cuticle and epidermal hair. Mammals of the tundra region have large body size and small tail and ear to avoid the loss of heat from the surface. The body is covered with fur for insulation. Insects have short life cycles which are completed during favourable period of the year.

3.2. FOREST ECOSYSTEM

The forest ecosystem includes a complex assemblage of different kinds of biotic communities. Optimum conditions such as temperature and ground moisture are responsible for the establishment of forest communities.

The nature of soil, climate and local topography determine the distribution of trees and their abundance in the forest vegetation. Forests may be evergreen or deciduous. They are distinguished on the basis of leaf into broad-leafed or needle leafed coniferous forests in the case of temperate areas.

The forest ecosystems have been classified into three major categories: coniferous forest, temperate forest and tropical forest. All these forest biomes are generally arranged on a gradient from north to south latitude or from high to lower altitude.

Do you know?

Dart Frogs got their name because hunters would tip their arrows in the frog's poisons. Sadly, because people are cutting down rainforests for farming and ranching, Poison Dart Frogs are at risk. The Blue Poison Dart Frog is the most endangered due to the pet-shop market.

3.2.1. Coniferous forest (boreal forest):

- Cold regions with high rainfall, strong seasonal climates with long winters and short summers are characterised by boreal coniferous forest
- This is characterised by evergreen plant species such as Spruce, fir and pine trees, etc and by animals such as the lynx, wolf, bear, red fox, porcupine, squirrel, and amphibians like Hyla, Rana, etc

- Boreal forest soils are characterized by thin podozols and are rather poor. Both because, the weathering of rocks proceeds slowly in cold environments and because the litter derived from conifer needle (leaf) is decomposed very slowly and is not rich in nutrients.
- These soils are acidic and are mineral deficient. This is due to movement of large amount of water through the soil, without a significant counter-upward movement of evaporation, essential soluble nutrients like calcium, nitrogen and potassium which are leached sometimes beyond the reach of roots. This process leaves no alkaline oriented cations to encounter the organic acids of the accumulating litter.
- The productivity and community stability of a boreal forest are lower than those of any other forest ecosystem.

3.2.2. Temperate deciduous forest:

- The temperate forests are characterised by a moderate climate and broad-leafed deciduous trees, which shed their leaves in fall, are bare over winter and grow new foliage in the spring.
- The precipitation is fairly uniform throughout.
- Soils of temperate forests are podozolic and fairly deep.

3.2.3. Temperate evergreen forest:

- Parts of the world that have Mediterranean type of climate are characterised by warm, dry summers and cool, moist winters.
- These are commonly inhabitated by low broad leafed evergreen trees.
- Fire is an important hazardous factor in this ecosystem and the adaptation of the plants enable them to regenerate quickly after being burnt.

Do you know?

Penguins are warm blooded. Just like whales, penguins have a layer of fat under their skin called "blubber". Overtop of this they are covered with fluffy "down" feathers and overtop of those they have their outer feathers which overlap to seal in warmth. Penguins rub oil from a gland onto their feathers to help make them waterproof and wind proof.

3.2.4. Temperate rain forests:

- The temperate rain forests exhibit a marked seasonality with regard to temperature and rainfall.
- Rainfall is high, and fog may be very heavy. It is the important source of water than rainfall itself.
- The biotic diversity of temperate rain forests is high as compared to other temperate forest. However, the diversity of plants and animals is much low as compared to the tropical rainforest.

Do you know?

Frog's tongues are attached to the front of their mouths rather than at the back like humans. When a frog catches an insect it throws its sticky tongue out of it's mouth and wraps it around its prey. The frog's tongue then snaps back and throws the food down its throat.

3.2.5. Tropical rain forests:

- Tropical rain forests occur near the equator.
- Tropical rain forests are among the most diverse and rich communities on the earth.
- Both temperature and humidity remain high and more or less uniform.
- The annual rainfall exceeds 200 cm and is generally distributed throughout the year.
- The flora is highly diversified
- The extreme dense vegetation of the tropical rain forests remains vertically stratified with tall trees often covered with vines, creepers, lianas, epiphytic orchids and bromeliads.
- The lowest layer is an understory of trees, shrubs, herbs, like ferns and palms.
- Soil of tropical rainforests are red latosols, and they are very thick.
- The high rate of leaching makes these soils virtually useless for agricultural purposes, but when left undisturbed, the rapid cycling of nutrients within the litter layer, formed due to decomposition can compensate for the natural poverty of the soil.
- Undergrowth is restricted in many areas by the lack of sunlight at ground level.

3.2.6. Tropical seasonal forests:

- Tropical seasonal forests also known as monsoon forest occur in regions where total annual rainfall is very high but segregated into pronounced wet and dry periods.
- This kind of forest is found in South East Asia, central and south America, northern Australia, western Africa and tropical islands of the pacific as well as in India.

3.2.7. Subtropical rain forests:

- Broad-leaved evergreen subtropical rain forests are found in regions of fairly high rainfall but less temperature differences between winter and summer
- Epiphytes are common here.
- Animal life of subtropical forest is very similar to that of tropical rainforests.

3.3. INDIAN FOREST TYPES

India has a diverse range of forests from the rainforest of Kerala in the south to the alpine pastures of Ladakh in the north, from the deserts of Rajasthan in the west to the evergreen forests in the north-east. Climate, soil type, topography, and elevation are the main factors that determine the type of forest. Forests varied according to their nature and composition, the type of climate in which they thrive, and its relationship with the surrounding environment.

Forest types in India are classified by Champion and Seth into sixteen types.

3.3.1. Tropical Wet evergreen forests

Wet evergreen forests are found along the Western Ghats, the Nicobar and Andaman Islands and all along the north-eastern region. It is characterized by tall, straight evergreen trees. The more common trees that are found here are the jackfruit, betel nut palm, jamun, mango, and hollock. The trees in this forest form a tier pattern: shrubs cover the layer closer to the ground, followed by the short structured trees and then the tall variety. Beautiful fern of various colours and different varieties of orchids grow on the trunks of the trees.

3.3.2. Tropical Semi-evergreen forests

Semi-evergreen forests are found in the Western Ghats, Andaman and Nicobar Islands, and the Eastern Himalayas. Such forests have a mixture of the wet evergreen trees and the moist deciduous trees. The forest is dense and is filled with a large variety of trees of both types.

Do you know?

Elephants' ears act as cooling devices. They can measure up to 2 square metres and they are equipped with an intricate web of blood vessels. When the animal flaps its ears, the blood temperature lowers by as much as 5°C.

3.3.3. Tropical Moist deciduous forests

Moist deciduous forests are found throughout India except in the western and the north-western regions. The trees are tall, have broad trunks, branching trunks and roots to hold them firmly to the ground. Some of the taller trees shed their leaves in the dry season. There is a layer of shorter trees and evergreen shrubs in the undergrowth. These forests are dominated by sal and teak, along with mango, bamboo, and rosewood.

3.3.4. Littoral and swamp

Littoral and swamp forests are found along the Andaman and Nicobar Islands and the delta area of the Ganga and the Brahmaputra. They have roots that consist of soft tissue so that the plant can breathe in the water.

3.3.5. Tropical Dry deciduous forest

Dry deciduous forests are found throughout the northern part of the country except in the North-East. It is also found in Madhya Pradesh, Gujarat, Andhra Pradesh, Karnataka, and Tamil Nadu. The canopy of the trees does not normally exceed 25 metres. The common trees are the sal, a variety of acacia, and bamboo.

3.3.6. Tropical Thorn forests

This type is found in areas with black soil: North, West, Central, and South India. The trees do not grow beyond 10 metres. Spurge, caper, and cactus are typical of this region.

3.3.7. Tropical Dry evergreen forest

Dry evergreens are found along Tamil Nadu, Andhra Pradesh and Karnataka coast. It is mainly hard-leaved evergreen trees with fragrant flowers, along with a few deciduous trees.

3.3.8. Sub tropical Broad-leaved forests

Broad-leaved forests are found in the Eastern Himalayas and the Western Ghats, along the Silent Valley. There is a marked difference in the form of vegetation in the two areas. In the Silent Valley, the poonspar, cinnamon, rhododendron, and fragrant grass are predominant. In the Eastern Himalayas, the flora has been badly affected by the shifting cultivation and forest fires. These wet forests consist mainly of evergreen trees with a sprinkling of deciduous here and there. There are oak, alder, chestnut, birch, and cherry trees. There are a large variety of orchids, bamboo and creepers.

3.3.9. Sub tropical Pine forests

Pine forests are found in the steep dry slopes of the Shivalik Hills, Western and Central Himalayas, Khasi, Naga, and Manipur Hills. The trees predominantly found in these areas are the chir, oak, rhododendron, and pine as well as sal, amla, and laburnum are found in the lower regions.

3.3.10. Sub tropical Dry evergreen forests

Dry evergreen forests normally have a prolonged hot and dry season and a cold winter. It generally has evergreen trees with shining leaves that have a varnished look. These forests are found in the Shivalik Hills and foothills of the Himalayas up to a height of 1000 metres.

3.3.11. Montane Wet temperate forests

In the North, Montane wet temperate forests are found in the region to the east of Nepal into Arunachal Pradesh, receiving a minimum rainfall of 2000 mm. In the North, there are three layers of forests: the higher layer has mainly coniferous, the middle layer has deciduous trees such as the oak and the lowest layer is covered by rhododendron and champa.

In the South, it is found in parts of the Niligiri Hills, the higher reaches of Kerala. The forests in the northern region are denser than in the South. Rhododendrons and a variety of ground flora can be found here.

3.3.12. Himalayan Moist temperate Forest

This type spreads from the Western Himalayas to the Eastern Himalayas. The trees found in the western section are broad-leaved oak, brown oak, walnut, rhododendron, etc. In the Eastern Himalayas, the rainfall is much heavier and therefore the vegetation is also more lush and dense. There are a large variety of broad-leaved trees, ferns, and bamboo. Coniferous trees are also found here, some of the varieties being different from the ones found in the South.

Do you know?

All birds have feathers and feathers do many jobs for birds. It keeps them warm, wing feathers allow flight and tail feathers are used for steering. The color of the feathers can be used to hide the bird or to help the bird find a mate.

3.3.13. Himalayan Dry temperate Forest

This type is found in Lahul, Kinnaur, Sikkim, and other parts of the Himalayas. There are predominantly coniferous trees, along with broad-leaved trees such as the oak, maple, and ash. At higher elevation, fir, juniper, deodar, and chilgoza are found.

3.3.14. Sub alpine forest

Sub alpine forests extend from Kashmir to Arunachal Pradesh between 2900 to 3500 metres. In the Western Himalayas, the vegetation consists mainly of juniper, rhododendron, willow, and black currant. In the eastern parts, red fir, black juniper, birch, and larch are the common trees. Due to heavy rainfall and high humidity the timberline in this part is higher than that in the West. Rhododendron of many species covers the hills in these parts.

3.3.15. Moist Alpine scrub

Moist alpines are found all along the Himalayas and on the higher hills near the Myanmar border. It has a low scrub, dense evergreen forest, consisting mainly of rhododendron and birch. Mosses and ferns cover the ground in patches. This region receives heavy snowfall.

3.3.16. Dry alpine scrub

Dry alpines are found from about 3000 metres to about 4900 metres. Dwarf plants predominate, mainly the black juniper, the drooping juniper, honeysuckle, and willow.

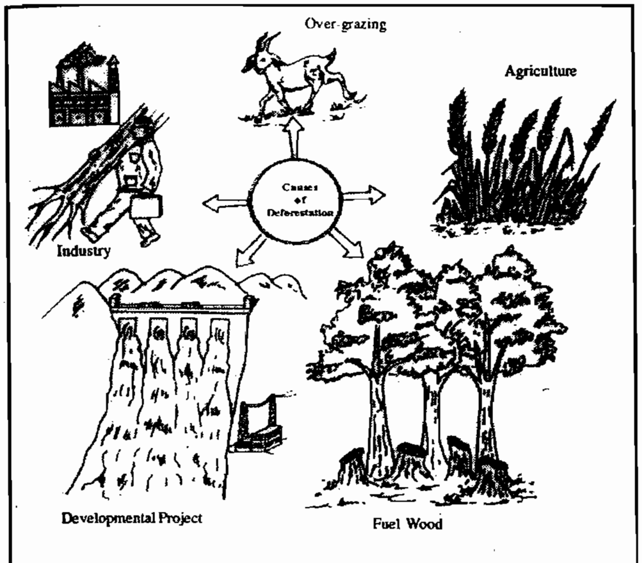
Importance of Forest

From air we breathe, the food we eat to the paper and wood we use; we depend on forest directly or indirectly. Without forests most of the areas would have been deserts

- Forests keep up the natural balance.
- Forests purify the air
- Forests provide micro climate
- Forests indirectly play a role in precipitation
- Forests prevent floods
- Forests prevent soil erosion
- Forests provide medicinal properties
- Forests provide us fuel and timber
- Forests provide raw materials for industries

3.4. DEFORESTATION

Indiscriminate felling of trees as a result of urbanization, industrialization, mining operations, and use of wood for domestic and other purposes, have caused heavy depletion of forests.



Causes of Deforestation

3.4.1. Causes

1) Shifting cultivation:

- In this practice a patch of land is cleared, vegetation is burned and the ash is mixed with the soil thus adding nutrients to the soil.
- This patch of land is used for raising crops for two to three years, and the yield is modest.
- Then this area is abandoned and is left to recover its fertility, and the same practice is repeated elsewhere on a fresh piece of land.
- All that is required for this method of cultivation is a set of simple tools, not high level of mechanisation.

2) development project:

- The human population have increased considerably, so with their requirements.
- Development projects like the hydroelectric projects, large dams and reservoirs, laying down of railway lines and roads are not only extremely beneficial, but they are also linked with several environmental problems.
- Many of these projects require immense deforestation.

Do you know?

Reptiles are cold-blooded animals that raise their body temperature by lying in the sun or lower it by crawling into the shade. Their body temperature changes to the temperature of its surroundings.

3) Fuel Requirements

- The increasing demand for firewood with ever growing population increases greater pressure on the forests, which results in increased intensity of deforestation.

4) Raw Materials

- Wood is used as a raw material by various industries for making paper, plywood, furniture, match sticks, boxes, crates, packing cases, etc.
- Industries also obtain their raw materials from plants such as drugs, scents and perfumes, resin, gums, waxes, turpentine, latex and rubber, tannis, alkaloids, bees wax.
- This exerted tremendous pressure on forest ecosystem and their unrestricted exploitation for various other raw materials is the main cause of degradation of the forest ecosystem.

5) Other Causes

- Deforestation also results from overgrazing, agriculture, mining, urbanization, flood, fire, pest, diseases, defence and communication activites.

3.4.2. How it affects?

- Closed forests (based on canopy level) have being diminished due to deforestation leading to increase in degraded forests.
- Forests recycle moisture from soil into their immediate atmosphere by transpiration where it again precipitates as rain.
- Deforestation results in an immediate lowering of ground water level and in long-term reduction of precipitation.
- Due to deforestation, this natural reuse cycle is broken and water is lost through rapid run off.
- Much of the mining activity in India is being carried out in forest regions. The obvious result is deforestation and erosion.
- Underground mining also significantly denudes forests because timber is used for supporting the roofs of mine galleries.
- A large number of abandoned mines are lying in bad shape and are under extensive gully erosion leading to degradation of the habitat.
- Deforestation affects the biota and neighbouring ecosystems, soil erosion, land degradation, alteration of ground water channels, pollution and scarce.

3.5. GRASSLAND ECOSYTEM

The grasslands are found where rainfall is about 25-75 cm per year, not enough to support a forest, but more than that of a true desert.

Typical grasslands are vegetation formations that are generally found in temperate climates.

In India, they are found mainly in the high Himalayas. The rest of India's grasslands are mainly composed of steppes and savannas.

Steppe formations occupy large areas of sandy and saline soil; in western Rajasthan, where the climate is semi-arid, average rainfall is less than 200 mm a year with a dry season of 10 to 11 months, and a large variation in rainfall.

The soil is always exposed, sometimes rocky but more often sandy with fixed or mobile dunes. Forage is available only during the brief wet season. The grass layer is sparse and consists mainly of annual grass species.

In the central and eastern parts of Rajasthan, where the rainfall is about 500 mm per year and the dry season is of six to eight months, dry savanna grazing ecosystems have developed. The light shade cast by the sparse population of trees like khetri (Prosopis cineraria) favours the growth of the grasses.

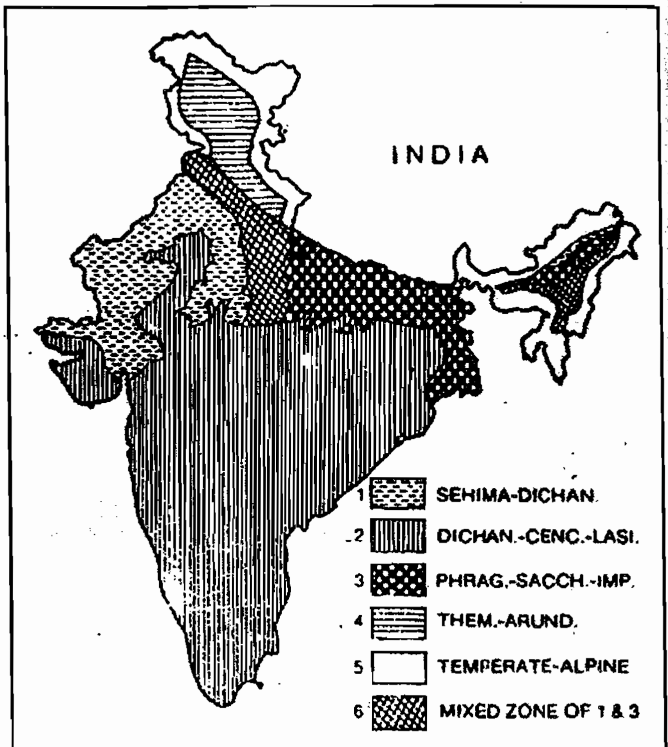
The major difference between steppes and savannas is that all the forage in the steppe is provided only during the brief wet season whereas in the savannas forage is largely from grasses that not only grow during the wet season but also from the smaller amount of regrowth in the dry season.

3.5.1. Types of Grasslands

Based on climatic conditions there are six types of grasslands found in the different regions of the Indian subcontinent. Four major types of grasslands are discussed here.

Do you know?

The elephant's trunk combines both nose and upper lip and transforms them into a single powerful organ that is able to touch, grasp and smell. It is strong enough to uproot a tree, sensitive enough to pick up a pea-sized fruit from the ground, and long enough to reach foliage high in the trees. The trunk is also used to drink by sucking up water and squirting it into the mouth.



Grassland types of India

1) **semi-arid zone (The Sehima-dichanthium type)**

- It covers the northern portion of Gujarat, Rajasthan (excluding Aravallis), western Uttar Pradesh, Delhi and Punjab.
- The topography is broken up by hill spurs and sand dunes.
- senegal, Calotropis gigantia, Cassia auriculata, Prosopis cineraria, Salvadora oloides and zizyphus Nummularia which make the savanna rangeland look like scrub.

2) **dry sub humid zone (The Dichanthium-cenchrus-lasitrrus type)**

- It covers the whole of peninsular India (except Nilgiri).
- The thorny bushes are Acacia catechu, Mimosa, Zizyphus (ber) and sometimes fleshy Euphorbia, along with low trees of Anogeissus latifolia, Soymida febrifuga and other deciduous species.
- Sehima (grass)is more prevalent on gravel and the cover may be 27%. Dichanthium (grass) flourishes on level soils and may cover 80% of the ground.

3) **moist subhumid zone(The Phragmities-sacchrum-imperata type)**

- It covers the Ganga alluvial plain in Northern India.

- The topography is level, low lying and ill-drained.
- Bothriochloa pertusa, Cypodon dactylon and Dichanthium annulatum are found in transition zones.
- The common trees and shrubs are Acacia arabica, hogeissus, la tifolia, Butea monosperma, Phoenic sylvestris and Zizyphus nummularia. Some of these are replaced by Borassus sp in the palm savannas especially near Sunderbans.

4) The Themeda - Arundinella type

- This extends to the humid montane regions and moist sub-humid axeas of Assam, Manipur, West Bengal, Uttar Pradesh, Punjab, Himachal Pradesh and Jammu and Kashmir.
- The savanna is derived from the humid forests on account of shifting cultivation and sheep grazing.

3.5.2. Economic importance of grasslands

- India teems with animals of all shapes and sizes from the black buffaloes to sheep's and there are millions of them.
- The livestock wealth plays a crucial role in Indian life. It is a major source of fuel, draught power, nutrition and raw material for village industries.
- This huge mass of livestock needs fodder for sustenance but there is not enough of it.
- Only about 13 million hectares in the country are classified as permanent grazing lands. On top of it, they exist in a highly degraded state.
- Grassland biomes are important to maintain the population of many domesticated and wild herbivores such as horse, mule, ass, cow, pig, sheep, goat, buffalo, camel, deer, zebra, etc. which provide food, milk, wool, hide or transportation to man.
- Indian Grasslands and Fodder Research Institute, Jhansi and Central Arid Zone Research institute, Jodhpur.

3.5.3. Impact of grazing

- Due to heavy grazing pressure, the quality of grasslands deteriorates rapidly, the mulch cover of the soil reduces, microclimate becomes more dry and is readily invaded by xerophytic plants.
- Due to absence of humus cover, mineral soil surface is heavily trampled when wetness produces puddling of the surface layer. In turn it reduces the infiltration of water into the soil and accelerates its run off, producing drought.
- These changes contribute to the reduction of energy flow, and the disruption of the stratification and periodicity of the primary producers. It results in a breakdown of the biogeochemical cycles of water, carbon and nitrogen.
- Water and wind erosion completely deteriorates dry grassland microclimate.
- Intensive grazing results in increased areas of bare soil, which creates a new habitat for burrowing animals such as mice, jack-rabbits, gophers, prairie dogs, locusts etc., which render large areas of forage lands sterile.

3.5.4. Role of fire

- fire plays an important role in the management of grasslands.
- Under moist conditions fire favours grass over trees, whereas in dry conditions fire is often necessary to maintain grasslands against the invasion of desert shrubs.
- Burning increases the forage yields, e.g. Cynodon daotylon.

3.6. DESERT ECOSYSTEM

- Deserts are formed in regions with less than 25 cm of annual rainfall, or sometimes in hot regions where there is more rainfall, but unevenly distributed in the annual cycle.
- Lack of rain in the mid latitude is often due to stable high pressure zones; deserts in temperate regions often lie in "rain shadows", that is, where high mountains block off moisture from the seas.
- The climate of these biomes is modified by altitude and latitude. At high altitudes and at greater distance from the equator the deserts are cold and hot near equator and tropics.
- The perennial plant species like creosote bush, cactus, fetrocactus are scattered throughout the desert biomes.
- In shallow depressed areas with salt deposits sarcobatus, geesewood, seepwood and salt grasses are common.

Do you know?

Sri Venkateshwara Zoological Park located in Tirupati city in Andhra Pradesh is the largest zoo in the country. The Area of the zoo is 2212 hectares.

- Because water is the dominant limiting factor, the productivity of a given desert is almost directly dependent on the rainfall. Where soils are suitable, irrigation can convert deserts into some of our most productive agricultural land.
- Whether productivity is continuous or is only a temporary, 'bloom' depends on how well man is able to stabilise biogeochemical cycles and energy flow at the increased irrigation rates.
- As the large volume of water passes through the irrigation system, salts may be left behind that will gradually accumulate over the years until they become limiting, unless means of avoiding this difficulty are devised.

Do you know?

Polar bears are very well adapted to swimming, with a water-repellent coat and partially webbed feet.

3.6.1. Adaptations

Desert plants are under hot and dry conditions.

(i) These plants conserve water by following methods:

- They are mostly shrubs.
- Leaves are absent or reduced in size.
- Leaves and stem are succulent and water storing.
- In some plants even the stem contains chlorophyll for photosynthesis.
- Root system is well developed and spread over large area.

The annuals wherever present germinate, bloom and reproduce only during the short rainy season, and not in summer and winter. This is an adaption to desert condition.

(ii) The animals are physiologically and behaviorally adapted to desert conditions.

- They are fast runners.
- They are nocturnal in habit to avoid the sun's heat during day time.
- They conserve water by excreting concentrated urine.
- Animals and birds usually have long legs to keep the body away from the hot ground.
- Lizards are mostly insectivorous and can live without drinking water for several days.
- Herbivorous animals get sufficient water from the seeds which they eat.
- Camel is known as the ship of the desert as it can travel long distances without drinking water for several days.
- Mammals as a group are poorly adapted to deserts but some species have become secondarily adapted. A few species of nocturnal rodents can live in the desert without drinking water.

3.6.2. Indian Desert – Thar desert (hot)

- The climate of this region is characterised by excessive drought, the rainfall being scanty and irregular.
- The winter rains of northern India rarely penetrate into the region.
- The cold season starts from about the middle of November to the middle of March.
- This season is characterized by extreme variations of temperature and the temperature is frequently below freezing point at night.
- During April to June the heat are intense, frequent scorching winds prevail with great desiccating.
- The relative humidity of the atmosphere is always low.
- The climate is hostile to all vegetation, only plants and animals possessing special adaptations being able to establish themselves.

(a) Flora

These adaptations in general are of two types, having two distinct objects in view: to enable the plant to obtain water, and to retain it when obtained.

- The bulk of the vegetation consists of a kind of scrub made up of shrubs and perennial herbs, capable of great drought resistance.
- There are a few trees and these are stunted and generally thorny or prickly, thus protecting themselves against plant feeding animals.

The proper desert plants may be divided into two main groups.

i) depending directly upon on rain and

ii) those depending on the presence of subterranean water.

The first group consists of two types:

- depending directly upon on the rain are of two types - the 'ephernerals' and the rain perennials'.
- The ephernerals are delicate annuals, apparently free from any xerophilous adaptations, having slender stems and root-systems and often large

flowers. They appear almost immediately after rain, develop flowers and fruits in an incredibly short time, and die as soon as the surface layer of the soil dries up.

- The rain perennials are visible above the ground only during the rainy season, but have a perennial underground stem.
- The second group - depending on the presence of subterranean water
- By far the largest number of indigenous plants are capable of absorbing water from deep below the surface of the ground by means of a well-developed root system, the main part of which generally consists of a slender, woody tap root of extraordinary length.
- Generally, various other xerophilous adaptations are resorted to such as reduced leaves, thick hairy growth, succulence, coatings of wax, thick cuticle, protected stomata, etc., all having for their object of reduction of transpiration.

(b) Fauna

- It is home to some of India's most magnificent grasslands and sanctuary for a charismatic bird, the Great Indian Bustard.
- Among the mammal fauna, the blackbuck, wild ass, chinkara, caracal, Sandgrouse and desert fox inhabit the open plains, grasslands, and saline depressions.
- The nesting ground of Flamingoes and the only known population of Asiatic wild Ass lies in the remote part of Great Rann, Gujarat.
- It is the migration flyway used by cranes and flamingos.
- Some endemic flora species of Thar Desert includes Calligonum Polygonoides, Prosopis cineraria, Tecomella undulate, Cenchrus biflorus and Sueda fruticosa , etc.

Do you know?

According to Global Forest Resource Assessment Report (Food and Agricultural Organization (FAO) 2005), India ranks among the top ten countries in terms of forest area. India has 1.8 % of the global forest area with per capita forests of 0.08 ha.

3.6.3. Cold Desert/ Temperate Desert

Cold desert of India include areas of ladak, leh and kargil of kashmir and spiti valley of Himachal Pradesh and some parts of northern Uttaranchal and Sikkim. These arid areas are not affected by the Indian monsoons because they lie in the rain-shadow of the Himalayan mountain systems.

Characterised by extreme cold weather and denuded terrain they are not suitable for plant growth. Isolated, scattered and over grazed herbaceous shrubs are found. Grazing period is less than 3-4 months.

The flora and fauna is unique to the area. Oak, pine, deodar, birch and rhododendron are the important trees and bushes found there. Major animal include yaks, dwarf cows, and goats.

3.6.4. Characters

- Severe arid conditions - Dry Atmosphere
- Temperature less than 00 C for most of the period, drops to –50oC during winter.
- insignificant monsoonal - Mean annual rainfall less than 400mm
- Heavy snowfall occurs between November and march.
- Soil type - sandy to sandy loam
- Soil pH - neutral to slight alkaline.
- Soil nutrient - Poor organic matter content
- Soil has low water retention capacity.
- Wind erosion is more common.
- Narrow growing period, mostly during the summer.
- Due to aforesaid extreme cold conditions, growth of vegetation is slow and of slunted nature.

Bio-diversity

- Cold desert is the home of highly adaptive, rare endangered fauna, such as Asiatic Ibex, Tibetan Argali, Ladakh Uriyal, Bharal, Tibetan Antelope (chiru), Tibetan Gazelle, Wild Yak, Snow Leopard, Brown Bear, Tibetan Wolf, Wild Dog and Tibetan Wild Ass ('Kiang' a close relative of the Indian wild ass), Woolly hare, Black Necked Crane, etc.
- Cold desert comprises of alpine mesophytes and desert vegetation.
- Dry temperature zone : Betula utilis, Salix spp. Juniperus recurva.
- Alphine zone : Junipers, Birch, Rhododendron with grasses.
- Perpetual snow zone : No vegetation due to permanently frozen soil.

3.7. DESERTIFICATION

It is the destruction of the biological potential of the land which can ultimately lead to desert like conditions. In arid and semiarid regions, the restoration of the fragile ecosystem is very slow, and issues like deforestation, mining enhances the desertification. Desertification is a main problem faced by desert adjoining areas, which stretches across parts of Rajasthan, Gujarat, Punjab and Haryana.

The cause of this process is not climatic changes, droughts, etc. but human actions. Increase in population and lack of alternative employment opportunities have left the people living in the Thar desert with no choice but to continue grazing cattle even in its inhospitable conditions.

Causes

- Population pressure
- Increase in cattle population
- Increased agriculture
- Development activities
- Deforestation

3.7.1. Status of Indian desertification

As per the Desertification and Land Degradation Atlas of India, 2007, the percentage of country under dry lands is 69.6%. The total area undergoing the process of land degradation in India is 105.48 million hectares, which constitutes 32.07 percentage of India's total land area.

81.45 million hectares area of the country is under desertification (land degradation within drylands). The details of drylands undergoing desertification are given below:

Arid - 34.89 million hectares
Semi-Arid - 31.99 million hectares
Dry sub-humid - 14.57 million hectares

Control measures

India as a signatory to United Nations Convention to Combat Desertification (UNCCD) has submitted four National Reports to UNCCD in the years 2000, 2002, 2006 and 2010. The fourth report was submitted in the year 2010. The National Action Programme for combating desertification was prepared in 2001 to take appropriate action in addressing the problems of desertification.

Some of the major programmes currently implemented that address issues related to land degradation and desertification are

- Integrated Watershed Management Programme (IWMP),
- National Afforestation Programme (NAP),
- National Mission for Green India (GIM),
- The Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS),
- Soil Conservation in the Catchment of River Valley Project and Flood Prone River,
- National Watershed Development Project for Rainfed Areas (NWDPRA),
- Desert Development Programme (DDP)
- Fodder and Feed Development Scheme-component of Grassland Development including Grass Reserves, Command Area Development and Water Management (CADWM) programme etc.

3.7.2. Afforestation

- The desert regions of Rajasthan, Gujarat, Haryana, Punjab and Trans-Himalayan regions are in scarce of vegetation.
- People require fire wood, timber and fodder for their domestic consumptions and livestock.
- Presence of vegetation prevents the soil erosion and modifies the hostile climate.
- Thus desert Afforestation is inevitable in order to modify the climate, desertification and to meet the demands of people living in that region.

Problems for Afforestation

- Hostile climate.
- Shallow, sandy and stony soil
- poor moisture holding capacity
- Poor nutrient status.
- Wind erosion.
- Grazing pressure.

Unless swift to conservation measures are taken and proper employment opportunities are found for the local people, the increasing density of the human and cattle population in this desert area will inexorably lead to further desertification.

Do you know?

Spider silk is possibly the strongest material in the world! Scientists believe that if they gathered the same weight of spider web as a piece of steel, the web would be much stronger than the steel! As hard as scientists try, they cannot match or copy the silk.

◆ ◆ ◆

CHAPTER - 4

AQUATIC ECOSYSTEM

Ecosystems consisting of water as the main habitat are known as aquatic ecosystems. Aquatic ecosystems are classified based on their salt content.

i) Fresh water ecosystems- The salt content of fresh bodies is very low, always less than 5 ppt (parts per thousand). E.g lakes, ponds, pools, springs, streams, and rivers

ii) Marine ecosystems - the water bodies containing salt concentration equal to or above that of sea water (i.e., 35 ppt or above). E.g shallow seas and open ocean

iii) Brackish water ecosystems – these water bodies have salt content in between 5 to 35 ppt. e.g. estuaries, salt marshes, mangrove swamps and forests.

4.1. AQUATIC ORGANISMS

The aquatic organisms are classified on the basis of their zone of occurrence and their ability to cross these zones.

The organisms (both flora and fauna) in the aquatic ecosystem are unevenly distributed but can be classified on the basis of their life form or location into five groups

i) Neuston:

- These are unattached organisms which live at the air-water interface such as floating plants, etc.
- Some organisms spend most of their lives on top of the air-water interface such as water striders, while others spend most of their time just beneath the air-water interface and obtain most of their food within the water.
  - E.g., beetles and back-swimmers.

ii) Periphyton:

- These are organisms which remain attached to stems and leaves of rooted plants or substances emerging above the bottom mud such as sessile algae and their associated group of animals.

iii) Plankton:

- This group includes both microscopic plants like algae (phytoplankton) and animals like crustaceans and protozoans (zooplankton) found in all aquatic ecosystems, except certain swift moving waters.
- The locomotory power of the planktons is limited so that their distribution is controlled, largely, by currents in the aquatic ecosystems.

iv) Nekton:

- This group contains animals which are swimmers.
- The nektons are relatively large and powerful as they have to overcome the water currents.
- The animals range in size from the swimming insects (about 2 mm long) to the largest animals, the blue whale.

v) Benthos:

- The benthic organisms are those found living in the bottom of the water mass.
- Practically every aquatic ecosystem contains well developed benthos.

4.1.1. Factors Limiting the Productivity of Aquatic Habitats

> Sunlight and oxygen are most important limiting factors of the aquatic ecosystems whereas moisture and temperature are the main limiting factors of terrestrial ecosystem.

Sunlight :

- Sunlight penetration rapidly diminishes as it passes down the column of water. The depth to which light penetrates a lake determines the extent of plant distribution.
- Based on light penetration and plant distribution they are classified as photic and aphotic zones

Photic zone :

- It is the upper layer of the aquatic ecosystems, up to which light penetrates and within which photosynthetic activity is confined.
- The depth of this zone depends on the transparency of water.
- Both photosynthesis and respiration activity takes place.
- photic (or "euphotic") zone is the lighted and usually well-mixed portion that extends from the lake surface down to where the light level is 1% of that at the surface.

Aphotic zone :

- The lower layers of the aquatic ecosystems, where light penetration and plant growth are restricted forms the aphotic zone.
- Only respiration activity takes place.
- aphotic zone is positioned below the littoral and photic zones to bottom of the lake where light levels are too low for photosynthesis. Respiration occurs at all depths so the aphotic zone is a region of oxygen consumption. This deep, unlit region is also known as the profundal zone.

Winterkill

Snow cover of ice on water body can effectively cut off light, plunging the waters into darkness. Hence photosynthesis stops but respiration continues. Thus in shallow lakes, the oxygen get depleted. Fish die, but we won't know it until the ice melts and we find floating fish. This condition is known as winterkill.

Dissolved oxygen :

- In aquatic ecosystems oxygen is dissolved in water, where its concentration varies constantly depending on factors that influence the input and output of oxygen in water.
- In fresh water the average concentration of dissolved oxygen is 0.0010 per cent (also expressed as 10 parts per million or 10 ppm) by weight, which is 150 times lower than the concentration of oxygen in an equivalent volume of air.
- Oxygen enters the aquatic ecosystem through the air water interface and by the photosynthetic activities of aquatic plants.
- Therefore, the quantity of dissolved oxygen present in an ecosystem depends on the rate at which the aforesaid two processes occur.
- Dissolved oxygen escapes the water body through air-water interface and through respiration of organisms (fish, decomposers, zooplanktons, etc).
- The amount of dissolved oxygen retained in water is also influenced by temperature. Oxygen is less soluble in warm water. Warm water also enhances decomposer activity. Therefore, increasing the temperature of a waterbody increases the rate at which oxygen is depleted from water.
- When the dissolved oxygen level falls below 3-5 ppm, many aquatic organisms are likely to die.

Other limiting factors which influence on aquatic productivity are

Transparency :

- Transparency affects the extent of light penetration.
- Suspended particulate matters such as clay, silt, phytoplankton, etc make the water turbid.
- Consequently it limits the extent of light penetration and the photosynthetic activity in a significant way.

Temperature:

- The water temperature changes less rapidly than the temperature of air because water has a considerably higher specific heat than air, i.e. larger amounts of heat energy must be added to or taken away from water to raise or lower its temperature.
- Since water temperatures are less subject to change, the aquatic organisms have narrow temperature tolerance limit.
- As a result, even small changes in water temperature are a great threat to the survival of aquatic organisms when compared to the changes in air temperatures in the terrestrial organisms.

The classification of organisms and limiting factors discussed here apply in general to all aquatic ecosystems - lakes,Ponds, Rivers, Streams, Estuaries, oceans and seas.

Do you know?

Bats are social animals. They hang UPSIDE DOWN when they sleep. They feed at night (they are "nocturnal") and spend the day sleeping in caves or in tree tops. They are the second largest group of mammals after rodents.

4.2. LAKE ECOLOGY

Any - body of standing water, generally large enough in area and depth, irrespective of its hydrology , ecology, and other characteristics is generally known as lake.

4.2.1. Ageing of Lakes

- Like any organism, lakes are born as they originate by various geological and geomorphic events, and 'grow' with time to change in their various morphological and functional characteristics and eventually die.
- They receive their water from surface runoff (sometimes also groundwater discharge) and along with it various chemical substances and mineral matter eroded from the land.
- Over periods spanning millennia, 'ageing' occurs as the lakes accumulate mineral and organic matter and gradually, get filled up.

The nutrient-enrichment of the lakes promotes the growth of algae, aquatic plants and various fauna. This process is known as natural eutrophication.

Similar nutrient enrichment of lakes at an accelerated rate is caused by human activities (discharge of wastewaters or agricultural runoff) and the consequent ageing phenomenon is known as 'cultural eutrophication'.

Do you know?

Poison Dart frogs live in rainforest habitats in Central and South America. They can be found in trees, as well as under leaves and logs and rocks on the floor of the forest. Because of their size, from ½ to 2 inches long, they are hard to see. Poison frogs warn predators with brilliant colors and patterns. There are many species of poison frogs that can be found in every color under the sun! They prey on invertebrates, especially certain ant species, which build up really strong poisons in the frog.

4.2.2. In India

- In India, natural lakes (relatively few) mostly lie in the Himalayan region , the floodplains of Indus, Ganga and Brahmaputra.
- In the semi-arid and arid regions of western and peninsular India, tens of thousands of water bodies have been constructed over millennia.
- Lake 'Sudarshan' in Gujarat's Girnar area was perhaps the oldest man-made lake in India, dating back to 300 BC.
- Lakes are also classified on the basis of their water chemistry. Based on the levels of salinity, they are known as Freshwater, Brackish or Saline lakes (similar to that of classification of aquatic ecosystem).
- On the basis of their nutrient content, they are categorized as Oligotrophic (very low nutrients), Mesotrophic (moderate nutrients) and Eutrophic (highly nutrient rich).
- Vast majority of lakes in India are either eutrophic or mesotrophic because of the nutrients derived from their surroundings or organic wastes entering them.

4.2.3. General Characteristics of Oligotrophic and eutrophic Lakes

		Type of lake	
Sl.no	Parameter	Oligotrophic	Eutrophic
1.	Aquatic plant production	Low	High
2.	Aquatic animal production	Low	High
3.	Aquatic plant nutrient flux	Low	High
4.	Oxygen in the hypolimnion (bottom layer)	Present	Absent
5.	Depth	Tend to be deeper	Tend to be shallower
6.	Water quality for domestic & industrial uses	Good	Poor
7.	Total salts or conductance	Usually lower	Sometimes higher
8.	Number of plant and animal species	Many	Fewer

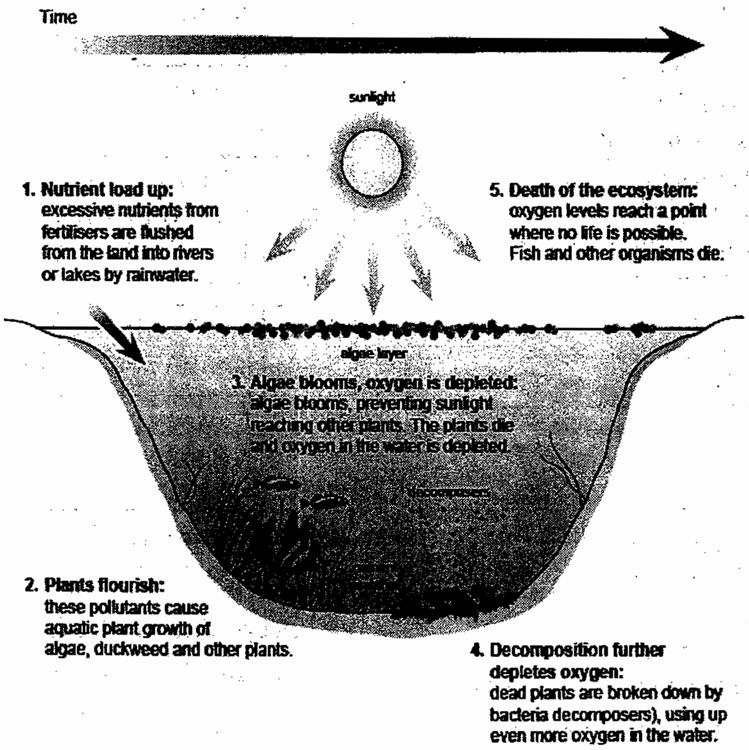
4.2.4. Removal of the nutrients from a lake

- Flushing with nutrient-poor waters.
- Deep water abstraction.
- On-site P-elimination by flocculation/flotation with water backflow, or floating Plant NESSIE with adsorbents.
- On-site algae removal by filters and P-adsorbers.

- On-site algae skimming and separator thickening.
- Artificial mixing / Destratification (permanent or intermittent).
- Harvest of fishes and macrophytes.
- Sludge removal.

4.3. EUTROPHICATION

- Greek word – Eutrophia means adequate & healthy nutrition.
- Eutrophication is a syndrome of ecosystem, response to the addition of artificial or natural substances such as nitrates and phosphates through fertilizer, sewage, etc that fertilize the aquatic ecosystem.
- The growth of green algae which we see in the lake surface layer is the physical identification of an Eutrophication.
- Eutrophication is the enrichment of an aquatic system by the addition of nutrients.
- It is primarily caused by the leaching of phosphate and - or nitrate containing fertilisers from agricultural lands into lakes or rivers.
- Some algae and blue-green bacteria thrive on the excess ions and a population explosion covers almost entire surface layer is known as algal bloom. This growth is unsustainable, however.
- As Algal Bloom covers the surface layer, it restricts the penetration of sunlight. Perhaps because another nutrient becomes limiting, death of aquatic organisms takes place.
- Oxygen is required by all respiring animals in the water and it is replenished by photosynthesis of green plants.
- The oxygen level is already low because of the population explosion and further oxygen is taken up by microorganisms which feed off the dead algae during decomposition process.
- Due to reduced oxygen level, fishes and other aquatic organism suffocate and they die.
- The new anaerobic conditions can promote growth of bacteria such as Clostridium botulinum which produces toxins deadly to aquatic organisms, birds and mammals.
- All this eventually leads to degradation of aquatic ecosystem and death of its organisms.
- It often leads to change in animal and plant population & degradation of water & habitat quality.


Time
sunlight
1. Nutrient load up:
excessive nutrients from fertilisers are flushed from the land into rivers or lakes by rainwater.
5. Death of the ecosystem:
oxygen levels reach a point where no life is possible. Fish and other organisms die.
algae layer
3. Algae blooms, oxygen is depleted:
algae blooms, preventing sunlight reaching other plants. The plants die and oxygen in the water is depleted.
decomposers
2. Plants flourish:
these pollutants cause aquatic plant growth of algae, duckweed and other plants.
4. Decomposition further depletes oxygen:
dead plants are broken down by bacteria decomposers), using up even more oxygen in the water.

Process of Eutrophication

4.3.1. Types

1. Natural

- Deposition of nutrients [such as depositional environments.
- When the nutrients flow into the system on temporal basics.
- Occurs over centuries
- Eg. Seasonally inundated tropical flood plains

2. Manmade

- Occurs in decades
- These inputs may come from untreated sewage discharges, runoff of fertilizer from farm fields, golf courses, park , etc. & from animal wastes.
- Combustion of fossil fuel [produces gases – nitrogen oxides
- Growing urban population in the coastal areas

4.3.2. Sources

1. Point sources

- Directly attributable to one influence
- In point source nutrient waste travels directly from source to water.
- Point sources are easy to regulate.

2. Non-point source

- Is from various ill-defined and diffuse sources
- Vary spatially and temporarily and are difficult to regulate.

Trees

T - Timber, the first and the foremost use of trees

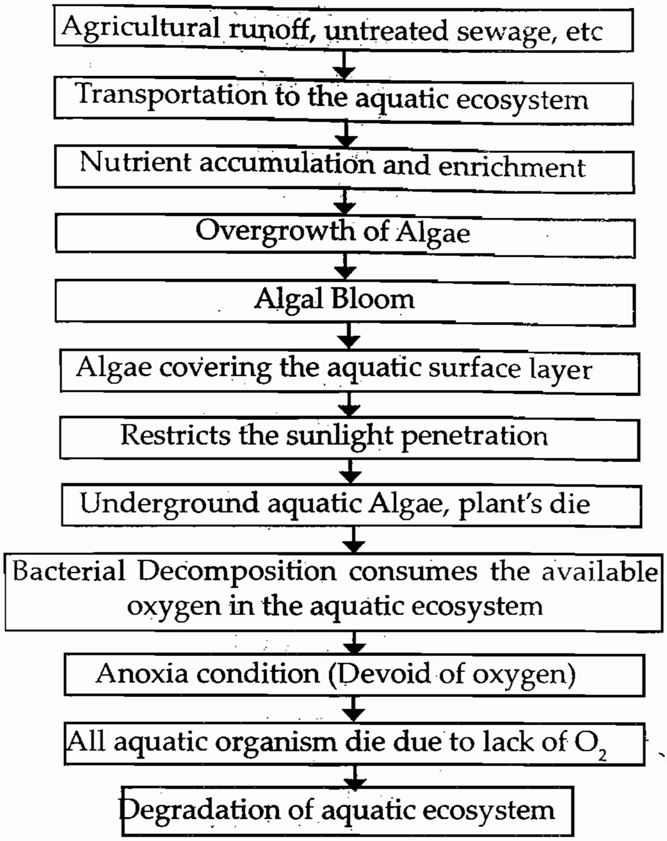
R - Restoration, reclamation and rejuvenation of denuded and disturbed soils by using trees to control soil erosion and desertification, protect watersheds, improve soil nutrient status (by growing nitrogen-fixing trees) and retain moisture in the soil

E - Ecological, eco-developmental and environmental use of trees for effective and efficient purification of the environment because trees act as oxygen banks and eliminate air pollutants; for abating or moderating temperature, noise and wind by planting trees as environmental screens, thus affecting the microclimate; for harboring wildlife; for maintaining biodiversity; and for conserving energy

E - Educational and recreational value in gardening, landscaping, art, culture and religion

S - Source of sustenance; i.e., food, fuel, fodder, fertilizer, fiber, medicine, tannin, dyes, oils, etc.

FLOW CHART


Agricultural runoff, untreated sewage, etc
Transportation to the aquatic ecosystem
Nutrient accumulation and enrichment
Overgrowth of Algae
Algal Bloom
Algae covering the aquatic surface layer
Restricts the sunlight penetration
Underground aquatic Algae, plant's die
Bacterial Decomposition consumes the available oxygen in the aquatic ecosystem
Anoxia condition (Devoid of oxygen)
All aquatic organism die due to lack of O2
Degradation of aquatic ecosystem

4.3.2. Effects

Change in ecosystem:

- Eutrophication eventually create detritus layer in the ponds & lakes and produces successively shallower depth of surface water.
- Eventually the water body is reduced into marsh whose plant community is transformed from an aquatic environment to recognizable terrestrial ecosystem.

Decreased biodiversity

- Algal blooms restrict the sunlight to penetrate & affects the photosynthesizing plants. It causes death of plants.
- Bacteria consumes all the oxygen on decomposition & results in devoid of oxygen. Eventually it leads to death of all living organism in aquatic ecosystem.

New species invasion

- Eutrophication may cause the ecosystem competitive by transforming the normal limiting nutrient to abundant level. This cause shifting in species composition of ecosystem

Toxicity

- Some algal blooms when die or eaten, release neuro & hepatotoxins which can kill aquatic organism & pose threat to humans. (e.g) Shellfish poisoning.
- Depletion of dissolved oxygen level.
- Increased incidences of fish kills & loss of desirable fish species & reduction in harvesting
- Loss of coral reefs.
- Decrease in water transparency and increased turbidity.
- Affects navigation due to increased turbidity.
- Colour (yellow, green, red), smell and water treatment problems.
- Increased biomass of inedible toxic phytoplankton
- Increase in bloom of gelatinous zooplankton
- Increased biomass of benthic and epiphytic algae
- Unsuitable for aesthetic recreation, and reduction in value of water body

Do you know?

The world's tallest tree is a coast redwood in California, measuring more than 360 ft or 110 m.

Mitigation

- Riparian buffer
- Interfaces between a flowing body of water and land created near the waterways, farms, roads, etc. in an attempt to filter pollution.
- Sediments and nutrients are deposited in the buffer zones instead of deposition in water.
- Successful method of minimizing the non-point pollution.
- Nitrogen testing & modeling
- N-Testing is a technique to find the optimum amount of fertilizer required for crop plants. It will reduce the amount of nitrogen lost to the surrounding area.
- Treatment of Industrial effluents
- Organic farming & Integrated Farming System.
- Reduction in livestock densities
- Improving the efficiency of use of fertilizer
- Treatment of runoff from street & storm drains
- Reduction in nitrogen emission from vehicles and power plants
- Increase in efficiency of nitrogen & phosphorous removal from municipal waste water

Policies

- Multi dimensional in Nature should include
- Education & awareness
- Research, monitoring & evaluation
- Regulations.
- Fiscal & economic incentives
- Ecosystem preservation & restoration

4.4. HARMFUL ALGAL BLOOMS

- Algae or phytoplankton are microscopic organisms that can be found naturally in coastal waters. They are major producers of oxygen and food for many of the animals that live in these waters.
- When environmental conditions are favorable for their development, these cells may multiply rapidly and form high numbers of cells and this is called an algal bloom.
- A bloom often results in a color change in the water. Algal blooms can be any color, but the most common ones are red or brown. These blooms are commonly referred to as red or brown tides.
- Most algal blooms are not harmful but some produce toxins and do affect fish, birds, marine mammals and humans. The toxins may also make the surrounding air difficult to breathe. These are known as Harmful Algal Blooms (HABs).

4.4.1. What is the use of algae?

- Most species of algae or phytoplankton serve as the energy producers at the base of the food web, without which higher life on this planet would not exist.

4.4.2. Why Red Tide is a misnomer?

- "Red Tide" is a common name for such a phenomenon where certain phytoplankton species contain pigments and "bloom" such that the human eye perceives the water to be discolored.
- Blooms can appear greenish, brown, and even reddish orange depending upon the type of organism, the type of water, and the concentration of the organisms.
- The term "red tide" is thus a misnomer because blooms are not always red, they are not associated with tides, they are usually not harmful, and some species can be harmful or dangerous at low cell concentrations that do not discolor the water.

- They are scientifically referred as Harmful Algal Blooms (HABs).

4.4.3. What are the causes of these blooms?

- Blooms occur when several colonies start combining rapidly when conditions such as nutrient concentrations, salinity and temperature are optimal.
- Blooms can be due to a number of reasons. Two common causes are nutrient enrichment and warm waters.
- Nutrient enrichment of water, especially phosphates and nitrogen, is often the result of pollution from nonpoint sources and can cause algal blooms.
- Water temperature has also been related to the occurrence of algal blooms, with unusually warm water being conducive to blooms.

4.4.4. How are HABs dangerous to fish and humans?

- HABs can deplete oxygen in water and lead to low dissolved oxygen levels.
- How it depletes oxygen? When masses of algae die and decompose, the decaying process can deplete oxygen in the water, causing the water to become so low in oxygen.
- When oxygen levels become too low, fish suffocate and die.
- Some algae species in blooms produce potent neurotoxins that can be transferred through the food web where they affect and even kill the higher forms of life such as zooplankton, shellfish, fish, birds, marine mammals, and even humans that feed either directly or indirectly on them.

Do you know?

Elephants live in a social hierarchy dominated by older females. Females travel in long-lasting social units of about half a dozen adult females and their offspring, with the unit being led by a single older female, the matriarch.

4.4.5. Is HAB's an environmental hazard?

- Harmful Algal Blooms are considered an environmental hazard because these events can make people sick when contaminated shellfish are eaten, or when people breathe aerosolized HAB toxins near the beach.
- In addition, HAB events can result in the closure of shellfish beds, massive fish kills, death of marine mammals and seabirds, and alteration of marine habitats.
- As a consequence, HAB events adversely affect commercial and recreational fishing, tourism, and valued habitats, creating a significant impact on local economies and the livelihood of coastal residents.

4.4.6. How do we get exposed to HAB toxins?

- Most illness associated with HAB exposure is the result of consuming toxins that are present in shellfish or finfish.
- Some HAB toxins can become airborne during a bloom and people can become ill by inhaling toxins.

4.4.7. Is it safe to eat seafood?

- In general, it is safe to eat seafood.
- However, consuming shellfish that have been harvested from waters with high levels of harmful algae and consuming fish that have lesions or that were caught in an area during an algal bloom can result in illness.

4.4.8. HABs and Climate Change

- Because the growth, toxicity, and distribution of harmful algal bloom (HAB) species are all tied to the environment, changes in climate can change the occurrence, severity, and impacts of HAB events.

4.5. WET LAND ECOSYSTEM

- Wetlands are areas intermediate in character between deepwater and terrestrial habitats, also transitional in nature, and often located between them.
- These habitats experience periodic flooding from adjacent deepwater habitats and therefore supports plants and animals specifically adapted to such shallow flooding or water logging of the substrate, were designated as wetlands.
- They included lake littorals (marginal areas between highest and lowest water level of the lakes), floodplains (areas lying adjacent to the river channels beyond the natural levees and periodically flooded during high discharge in the river) and other marshy or swampy areas where water gets stagnated due to poor drainage or relatively impervious substrata & Bogs, fens and mangroves due to similar ecological characteristics

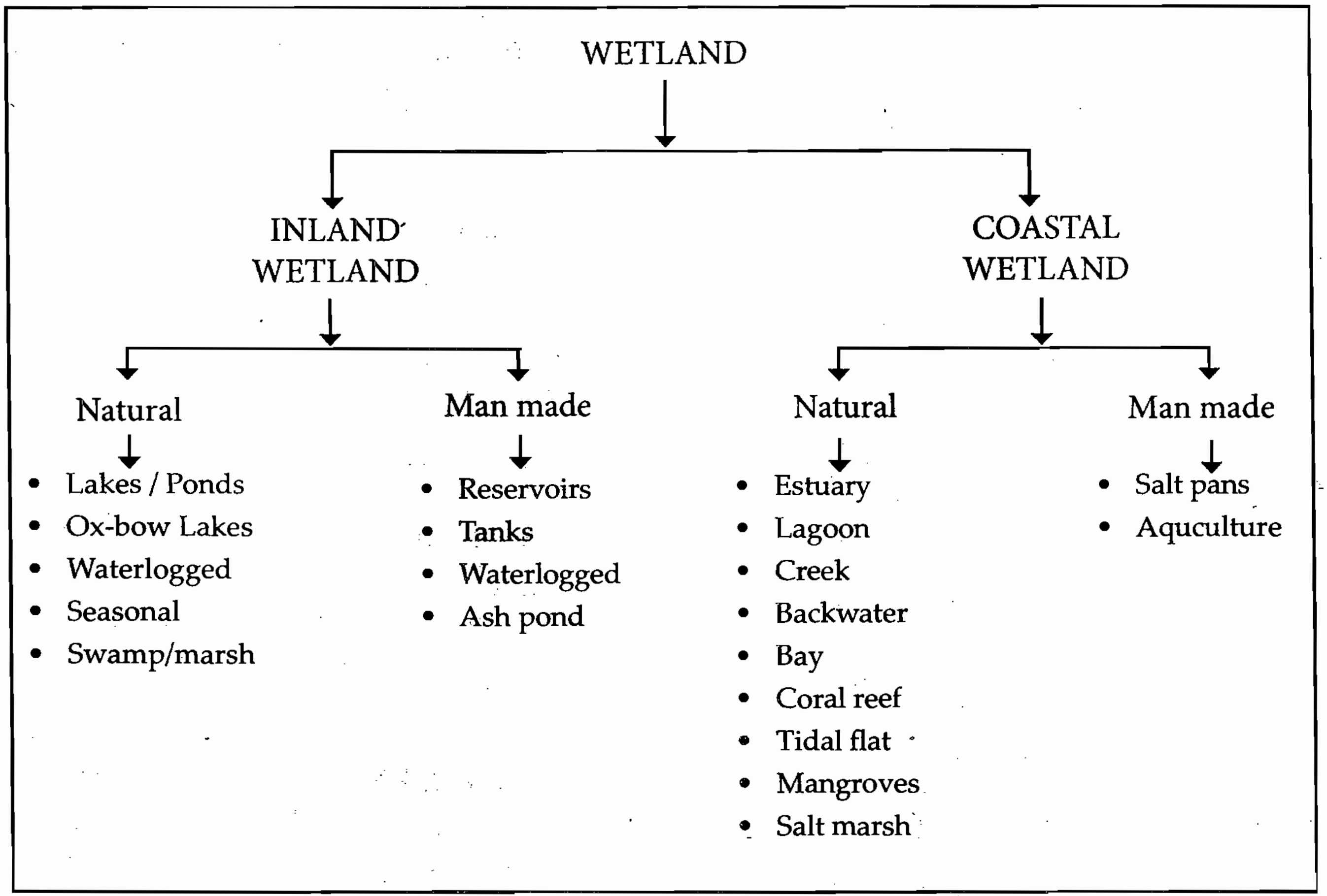
4.5.1. Definition

- ➢ Areas of marsh, fen, peatland/water, whether natural (or) artificial, permanent (or) temporary with water that is static (or) flowing, fresh, brackish (or) salt, including areas of marine water the depth of which at low tide does not exceed 6 mtrs.

4.5.2. Characteristics

- ➢ Covered by water (or) has waterlogged soil for atleast seven days during the growing season.
- ➢ Adopted plant life (hydrophytes)
- ➢ Hydric soils (not enough O2 available for some plants)

4.5.3. Wetlands Classification


WETLAND
INLAND WETLAND
COASTAL WETLAND
Natural
Man made
Natural
Man made
• Lakes / Ponds
• Ox-bow Lakes
• Waterlogged
• Seasonal
• Swamp/marsh
• Reservoirs
• Tanks
• Waterlogged
• Ash pond
• Estuary
• Lagoon
• Creek
• Backwater
• Bay
• Coral reef
• Tidal flat
• Mangroves
• Salt marsh
• Salt pans
• Aquculture

4.5.4. Functions of Wetlands

- ➢ Habitat to aquatic flora and fauna, as well as numerous species of birds, including migratory species.
- ➢ Filtration of sediments and nutrients from surface water
- ➢ Nutrients recycling
- ➢ Water purification
- ➢ Floods mitigation
- ➢ Maintenance of stream flow
- ➢ Ground water recharging
- ➢ Provide drinking water, fish, fodder, fuel, etc
- ➢ Control rate of runoff in urban areas
- ➢ Buffer shorelines against erosion
- ➢ Comprise an important resource for sustainable tourism, recreation and cultural heritage
- ➢ Stabilization of local climate
- ➢ Source of livelihood to local people
- ➢ Genetic reservoir for various species of plants (especially rice)
- ➢ Supporting specific diversity

4.5.5. Reasons for depletion

- ➢ Conversion of lands for agriculture
- ➢ Overgrazing
- ➢ Removal of sand from beds
- ➢ Aqua culture
- ➢ Habitat Destruction and Deforestation
- ➢ Pollution
- ➢ Domestic waste
- ➢ Agricultural runoff
- ➢ Industrial effluents
- ➢ Climate change

4.5.6. Mitigation

- Survey and demarcation
- Protection of natural regeneration
- Artificial regeneration
- Protective measures
- Afforestation (percentage survival to be indicated)
- Weed control
- Soil conservation measures & afforestation
- Wildlife conservation
- Removal of encroachments
- Eutrophication abatement
- Environmental awareness

4.5.7. Distinction from Lakes

- Although the Ministry of Environment and Forests has not adopted a clear distinction between lakes and wetlands, the National Lake Conservation Programme (NLCP) considers lakes as standing water bodies which have a minimum water depth of 3 m, generally cover a water spread of more than ten hectares, and have no or very little aquatic vegetation (macrophytes).
- These water bodies are used primarily for drinking water supplies, irrigation and/or recreation.
- Excessive growth of macrophytes (both submerged and free-floating) generally present in wetland, affects the water quality adversely and interfere with the utilization of the water body.
- However, marginal aquatic vegetation (wetlands), particularly comprising of emergent plants and those inhabiting waterlogged soils, is not only desirable but is to be promoted because it checks erosion, serves habitat for wildlife and helps improve water quality.
- Wetlands (generally less than 3 m deep over most of their area) are usually rich in nutrients (derived from surroundings and their sediments) and have abundant growth of aquatic macrophytes.
- They support high densities and diversity of fauna, particularly birds, fish and macro invertebrates, and therefore, have high value for biodiversity conservation. These shallow lakes are rightfully categorized as wetlands.
- lakes are generally less important when compared to wetland from the viewpoint of ecosystem and biodiversity conservation.

4.5.8. Comparison between Lake and Wetlands

Sl. no	Characteristic	Lake	Wetland (shallow lake)
1.	Origin	various process	Fluvial/ Geomorphic processes
2.	Water turnover	Permanent	Permanent or Temporary
3.	Water level changes	relatively small	Relatively Large
4.	Littoral: Pelagial ratio	Small	Large
5.	Thermal stratification	Yes	No
6.	Vertical mixing	Thermally regulated	Wind regulated
7.	Dominant Producer	Phyto plankton	Macrophytes
8.	Food chain	Grazing Pathway	Detritus Pathway
9.	Nutrient Cycles	Microbial loops less important	Microbial loop dominant
10.	Productivity	Low	High
11.	Trophic status	Oligo trophic	Mostly Eutrophic (Except desirable in bogs)
12.	Biodiversity	Generally low	Generally high
13.	Functions- Flood control	Less Significant	Significant
14.	Groundwater recharge	Negligible/ low	Low-high
15.	Waste treatment	No	Yes
16.	Management objectives	Control of eutrophication High Water quality	Biodiversity conservation Specific Functions

4.5.9. India's Wetlands

- Wetlands are areas of critical ecological significance: as they support biodiversity, support millions of people directly and indirectly, protect from storms, flood control, improve water quality, supply food, fiber and raw materials.
- India has totally 27,403 wetlands, of which 23,444 are inland wetlands and 3,959 are coastal wetlands. Wetlands occupy 18.4% of the country's area of which 70% are under paddy cultivation.
- Natural wetlands in India range from high altitude wetlands in Himalayas; flood plains of the major river systems; saline and temporary wetlands of the arid and semi-arid regions; coastal wetlands such as lagoons, backwaters, estuaries, mangroves, swamps and coral reefs, and so on.

Do you know?

Kannimara teak is one of the largest living teak tree in the world. It has an amazing girth of 6.48m and a crown height of 48.75m It is believed to be around 400 years old.

According to the local tribal belief here when this tree was tried to cut down, the blood spurted out from the place of cut. This tree was being since then worshipped by the local tribes in Parambikulam as "Virgin tree". Kannimara - 'Kanni' means 'Virgin'. This tree has been awarded 'Mahavriksha Puraskar' by the Government of India.

4.5.10. National Wetlands Conservation Programme (NWCP)

- NWCP was implemented in the year 1985-86.
- Under the programme, 115 wetlands (Annexure) have been identified by the Ministry which require urgent conservation and management interventions.

Aim

- Conservation of wetlands to prevent their further degradation and ensuring their wise use for the benefit of local communities and overall conservation of biodiversity.

Objectives

- to lay down policy guidelines for conservation and management of wetlands in the country.
- to provide financial assistance for undertaking intensive conservation measures in the identified wetlands.
- to monitor implementation of the programme; and to prepare an inventory of Indian wetlands.
- The Central Government is responsible for overall coordination of wetland conservation programmes and initiatives at the international and national levels. It also provides guidelines, financial & technical assistance to state govt.
- Since the land resources belong to them, the State Governments/UT Administration are responsible for management of wetlands and implementation of the NWCP for ensuring their wise-use.

4.5.11. Criteria for Identification of Wetlands of National Importance

- Criteria for identification of wetlands of national importance under NWCP are same as those prescribed under the 'Ramsar Convention on Wetlands' and are as given below:
- Sites containing representative, rare or unique wetland types

(i) If it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.

- Criteria based on species and ecological communities

(ii) If it supports vulnerable, endangered, or critically endangered species; or threatened ecological communities.

(iii) If it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.

(iv) If it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

- Specific criteria based on water birds

(v) If it regularly supports 20,000 or more water birds.

(vi) If it regularly supports 1% of the individuals in a population of one species or subspecies of waterbirds.

- Specific criteria based on fish

(vii) If it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.

(viii) If it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend. Specific criteria based on water/life and culture

(ix) If it is an important source of food and water resource, increased possibilities for recreation and eco-tourism, improved scenic values, educational opportunities, conservation of cultural heritage (historic or religious sites).

4.6. ESTUARY ECOSYSTEM

- Estuaries are located where river meets the sea. Estuaries are water bodies where the flow of freshwater from river mixes with salt water transported, by tide, from the ocean. Estuaries are the most productive water bodies in the world. They are located at the lower end of a river and are subject to tidal fluctuations.
- Estuaries are either once or twice, daily washed by the seawater.

4.6.1. Characters

- An Estuary is a semi enclosed coastal body of water with one or more rivers or streams flowing into it.
- It has a free connection with open sea.
- The complete salinity range from 0-35 ppt is seen from the head (river end) to the mouth (sea end) of an estuary.
- An estuary has very little wave action, so it provides a calm refuge from the open sea. It provides the shelter for some of the animals.
- It is the most productive region as it receives the high amount of nutrients from fresh and marine water.
- Estuaries are most heavily populated areas throughout the world, with about 60% of the world's population living along estuaries and the coast.
- Estuaries are typically classified by their geomorphological features or by water circulation patterns and can be referred to by many different names, such as bays, harbors, lagoons, inlets, etc.
- The banks of estuarine channels form a favoured location for human settlements, which use the estuaries for fishing and commerce, but nowadays also for dumping civic and industrial waste.
- Estuaries are usually biologically highly productive zones.
- They also act as a filter for some dissolved constituents in river water; these precipitate in the zone where river water meets seawater.
- More important is the trapping of suspended mud and sand carried by rivers which leads to delta formations around estuaries.

Coastal lakes which have their connection with the sea through small openings are better known as lagoons or backwaters. They exhibit a gradient in salinity from freshwater to marine depending upon the extent of influence of the sea water.

Estuary Formation:

Most estuaries can be grouped into four geomorphic categories based on the physical processes responsible for their formation:

(1) rising sea level; (2) movement of sand and sandbars; (3) glacial processes; and (4) tectonic processes.

4.6.2. A Healthy Estuary

- A healthy estuary supports a host of plants and animals. It stores and recycles Nutrients, traps sediment and forms a buffer between coastal catchments and the marine environment. It also absorbs traps and detoxifies pollutants, acting as a natural water filter. When all such processes remain functional an estuary is considered to be healthy state.
- Estuaries support diverse habitats, such as mangroves, salt marshes, sea-grass, mudflats etc.

4.6.3. Life in Estuary

- Only certain types of plants and animals specially adapted to the "brackish" estuarine waters flourish in the estuaries. Factors influencing the growth and distribution of organism in an estuary are its salinity and the amount of flooding.
- Estuaries are homes to all kind of terrestrial or land-based plants and animals, such as wood storks, pelicans, coniferous and deciduous trees and butterflies. Estuaries are also homes to unique aquatic plants and animals, such as sea turtles and sea lions, sea catfish, saltworts, eelgrass, saltgrasses, cordgrasses, sea grass, sedge and bulrush.

- Predators are important to the estuary because of their end position in most consumer food chains.

4.6.4. Benefits of Estuarine Ecosystem

Environmental Benefits

- Water quality regulation and groundwater recharge
- Habitat, breeding and nursery grounds for plants and animals
- Biological productivity
- Social Benefits
- Community values
- Indigenous values
- Recreation values
- Knowledge/Research values
- Economic Benefits
- Commercial fishing
- Ports and harbours
- Navigation
- Tourism
- Agriculture, aquaculture and industry
- Storm and erosion protection

4.6.5. India Estuarine Ecosystem

- The Country has 14 major, 44 medium and 162 minor rivers drains into the sea through various estuaries.
- Estuaries are an important and distinct component of the coastal landscape with highly complex ecosystems, varying physical – chemical properties and having highly diverse flora and fauna.
- Major estuaries occur in the Bay of Bengal. Many estuaries are locations of some of the major seaports.
- Most of the India's major estuaries occur on the east coast. In contrast, the estuaries on the west coast are smaller.

4.6.6. Issues of Indian Estuarine Ecosystem

- The specific issues which have affected the estuarine environment in the country are:

1. Water flow

- Changes in water flow in various estuaries, either far in excess or much lower than required (e.g., Hooghly, Narmada, Krishna, Godavari, Pulicat etc.)
- Modifications of the estuarine catchments (e.g Most of the Indian estuaries)

2. Pollution & Water Quality

- Pollution through industries and combined city sewage (e.g., all the Indian estuaries)

3. Recreation And Tourism

- Recreational boating (e g., Hooghly WB; Chilika, Orissa)
- Recreational fishing kg., Chilika)
- Navigation (e g., Hooghly)

4. Ports & Shipping

- Dredging (e.g., Hooghly)
- Shipping (r g., Hooghly)

5. Land-use

- Expansion of urban and rural settlements (e.g, Hooghly)~W, B, Krishna, Cauvery, Pulicat, Tn)
- Marinas, groynes, land reclamation and other structures (e.g., Hooghly, Pulicat)
- Mining & Industries (e.g., Hooghly, Zuari, Goa)
- Agriculture (e.g., all the Estuaries)
- Dumping of solid wastes (e g all the Indian estuaries)

6. Commercial Fishing & Aquaculture

- Over exploitation of target fish stock due to increased demand (e.g., all the Indian estuaries)
- Reclaiming the fringed areas for intensive aquaculture in pens ,
- obstructing the migratory routes of fish and prawn recruitment (e.g., Chilika, Pulicat)
- Polluting the environment through feeding of stocked fish and prawn in pens (Chilika)
- Destruction of biodiversity through prawn seed collection and operation of small-meshed nets (e.g., Hooghly, Chilika, Pulicat)

7. Climate Change

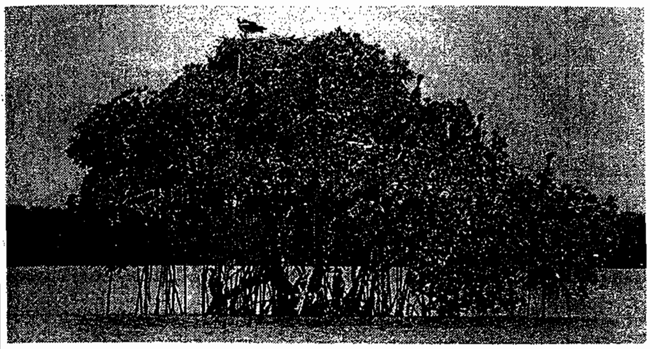
- Submergence of catchment areas due to rise in water level (e.g., all the major Indian estuaries)
- Change in biodiversity profile, affecting the production and productivity (e.g., all the major Indian estuary)

Do you know?

Snakes generally lay eggs, some snakes, such as boas, rattlesnakes and garter snakes, give birth to live young.

4.7. MANGROVES

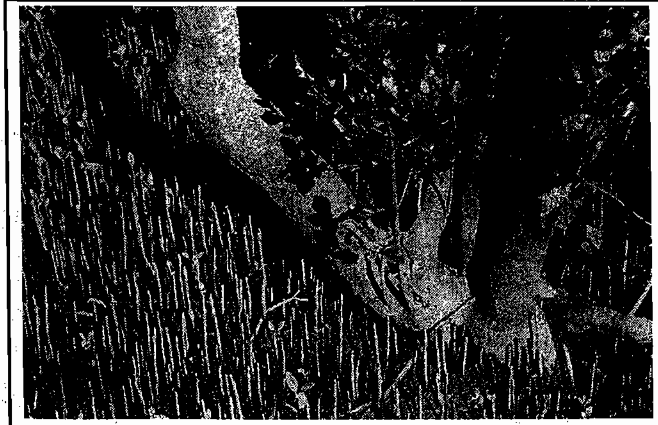
- Mangroves are the characteristic littoral plant formation of tropical and subtropical sheltered coastlines. Mangroves are trees and bushes growing below the high water level of spring tides which exhibits remarkable capacity for salt water tolerance. - FAO .



Mongrove tree

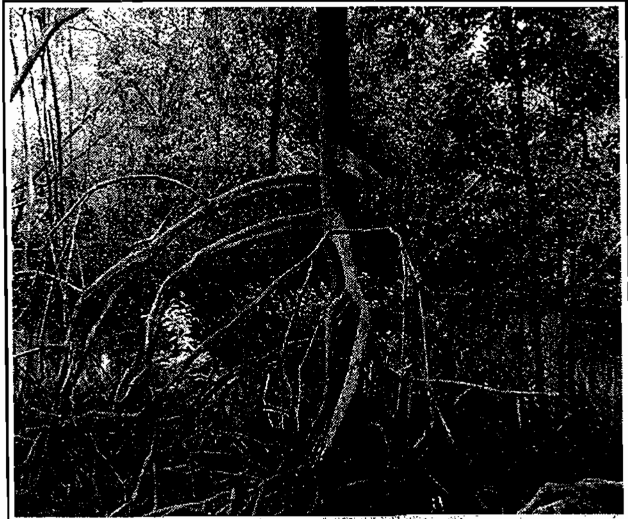
4.7.1. Characteristics of mangroves

- They are basically evergreen land plants growing on sheltered shores, typically on tidal flats, deltas, estuaries, bays, creeks and the barrier islands.
- The best locations are where abundant silt is brought down by rivers or on the backshore of accreting sandy beaches.
- Their physiological adaptation to salinity stress and to water logged anaerobic mud is high.
- They require high solar radiation and have the ability to absorb fresh water from saline/ brackish water.
- It produces pneumatophores (blind roots) to overcome respiration problem in the anaerobic soil conditions.



Pneumatophores

- Mangroves occur in variety of configurations. Some species (e.g. Rhizophora) send arching prop roots down into the water. While other (e.g. Avicennia) send vertical "Pneumatophores" or air roots up from the mud.
- Most mangrove vegetation has lenticellated bank which facilitates more water loss, produces coppices. Leaves are thick and contain salt secreting glands.
- Mangroves exhibit Viviparity mode of reproduction. i.e. seeds germinate in the tree itself (before falling to the ground). This is an adaptative mechanism to overcome the problem of germination in saline water.
- Some secrete excess salt through their leaves as if you look closely, you can see crystals of salt on the back of the leaves; others block absorption of salt at their roots.
- Adventitious roots which emerged from the main trunk of a tree above ground level are called stilt roots.



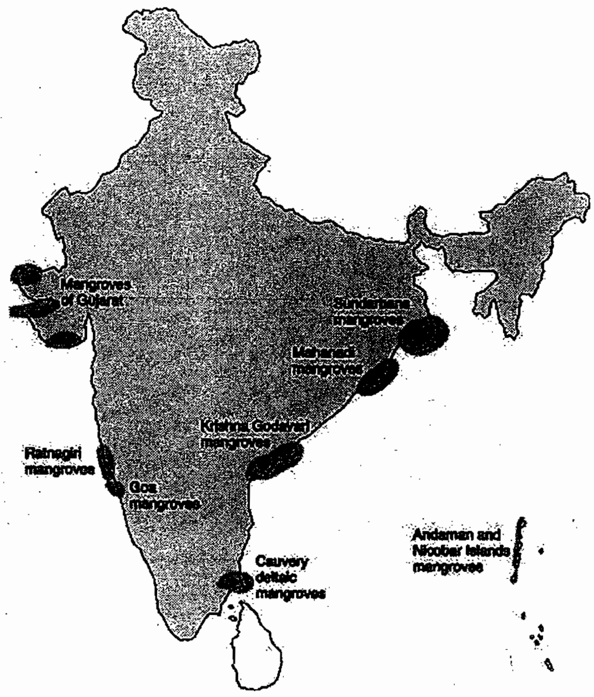
Stilt Roots

Do you know?

The word amphibian means two-lives. Amphibians spend their lives in the water and on land. All amphibians begin their life in water with gills and tails. As they grow, they develop lungs and legs for their life on land. Members of this animal class are frogs, toads, salamanders, newts, and caecilians or blindworms. Amphibians shed their skin as they grow. Usually the shed skin is eaten.

4.7.2. Mangrove profile in India

- The mangroves of Sundarbans are the largest single block of tidal holophytic mangroves of the world. The major species of this dense mangrove forest include Herritiera fames, Rhizophora spp., Bruguiera spp., Ceriops decandra, Sonneratia spp. and Avicennia spp., Nypa fruticans are found along the creeks. This mangrove forest is famous for the Royal Bengal Tiger and crocodiles. Mangrove areas are being cleared for agricultural use.
- The mangroves of Bhitarkanika (Orissa), which is the second largest in the Indian sub continent, harbour high concentration of typical mangrove species and high genetic diversity.
- Mangrove swamps occur in profusion in the intertidal mudflats on both side of the creeks in the Godavari-Krishna deltaic regions of Andhra Pradesh.



Indian Mangrove Profile

- Mangroves of Pichavaram and Vedaranyam are degraded mainly due to construction of aquaculture ponds and salt pans.
- On the west coast of India, mangroves, mostly scrubby and degraded occur along the intertidal region of estuaries and creeks in Maharashtra, Goa and Karnataka.
- The mangrove vegetation in the coastal zone of Kerala is very sparse and thin.
- In Gujarat (north-west coast) mangroves Avicennia marine, Avicennia officinalis and Rhizophora mucronata are found mainly in Gulf of Kachchh and the Kori creek.
- Mangroves are of scrubby type with stunted growth, forming narrow, discontinuous patches on soft clayey mud.
- The condition of the mangroves is improving especially in the Kori creek region, which is a paleodelta of the Indus river.
- In size, mangroves range from bushy stands of dwarf mangroves found in Gulf of Kuchchh, to taller stands found in the Sunderbans.
- On the Andaman & Nicobar Islands, the small tidal estuaries, neritic inlets and the lagoons support a dense and diverse undisturbed mangrove flora.

4.7.3. Role of mangroves

- Mangrove plants have (additional) special roots such as prop roots, pneumatophores which help to impede water flow and thereby enhance the deposition of sediment in areas (where it is already occurring), stabilize the coastal shores, provide breeding ground for fishes.
- Mangroves moderate monsoonal tidal floods and reduce inundation of coastal lowlands.
- It prevents coastal soil erosion.
- It protects coastal lands from tsunami, hurricanes and floods.
- Mangroves enhance natural recycling of nutrients.
- Mangrove supports numerous flora, avifauna and wild life.
- Provide a safe and favorable environment for breeding, spawning, rearing of several fishes.
- It protects coastal inland from adverse climatic elements.
- It supplies woods, fire wood, medicinal plants and edible plants to local people.
- It provides numerous employment opportunities to local communities and augment their livelihood.

Do you know?

The King Cobra is not only an excellent climber but a super swimmer as well. They live in forests near streams.

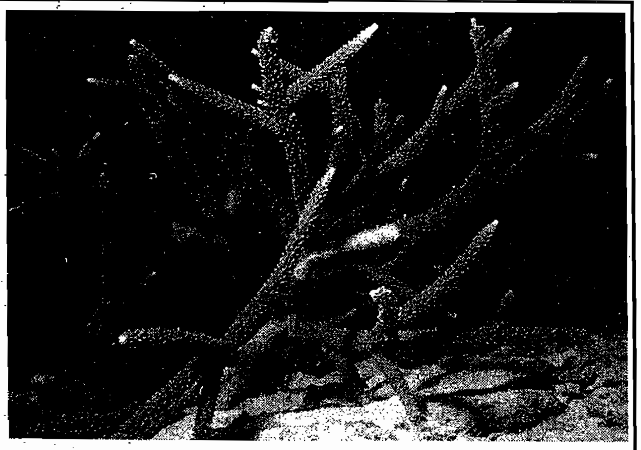
Fine, anoxic sediments deposited under mangroves act as sinks for a variety of heavy (trace) metals which are scavenged from the overlying seawater by colloidal particles in the sediments. By cleaning our air, they taking in carbon dioxide, storing the carbon in their roots, leaves, branches and in its surrounding silt, and release oxygen back to the atmosphere, along with a little methane gas.

4.7.4. Threat

- They are destroyed for conversion of area for agricultural purpose, fuel, fodder and, salinization, minig, oil spills, aquacultural (shrimp farming), use of chemical pesticides & fertilizers, industrial purposes.

4.8. CORAL REEFS

- Coral is actually a living animal. Coral has a symbiotic relationship (each gives something to the other and gets something back in return) with 'zooxanthellae' microscopic algae which live on coral [i.e. instead of living on the sea floor, the algae lives up on the coral which is closer to the ocean surface and so that the algae gets lots of light].



Coral

- Zooxanthellae assist the coral in nutrient production through its photosynthetic activities. These activities provide the coral with fixed carbon compounds for energy, enhance calcification ,and mediate elemental nutrient flux.
- The tissues of corals themselves are actually not the beautiful colors of the coral reef, but are instead clear (white). The corals receive their coloration from the zooxanthellae living within their tissues.
- The host coral polyp in return provides its zooxanthellae with a protected environment to live within, and a steady supply of carbon dioxide for its photosynthetic processes.
- There are two types of corals: hard corals and soft corals, such as sea fans and gorgonians. Only hard corals build reefs.
- The builders of coral reefs are tiny animals called polyps. As these polyps thrive, grow, then die, they leave their limestone (calcium carbonate) skeletons behind. The limestone is colonized by new polyps. Therefore, a coral reef is built up of layers of these skeletons covered ultimately by living polyps.
- The reef-building, or hermatypic corals can form a wide range of shapes. Coral reefs may be branched, table-like, or look like massive cups, boulders or knobs.
- While the majority of coral reefs are found in tropical and sub-tropical water, there are also deep water corals in colder regions.

4.8.1. Cold Water Corals:

- Cold-water corals inhabit deep, cold (39-55 degrees F), water. The United Nations Environment Programme reports that there are more cold-water coral reefs worldwide than tropical reefs.
- There are only about 6 different coral species associated in building with these reefs. The largest cold-water coral reef is the Rost Reef off Norway.

4.8.2. Features

- They occur in shallow tropical areas where the sea water is clean, clear and warm.
- The coral reef cover in Indian waters is roughly estimated upto 19,000 sq. Km.
- Coral reefs are one of the most productive and complex coastal ecosystems with high biological diversity.
- The high productivity is owing to the combination of its own primary production and support from its surrounding habitat.
- Reef building corals are a symbolic association of polyps (coral animals) and 'xooxanthellae' (the microscopic algae)
- The corals are generally slow growing colonies of animals while xooxanthellae are fast growing plants.

- Even though corals live in nutrient poor waters, their capability to recycle the scarce nutrients (by the whole nutrient community) is enormous.
- In coral reef ecosystem, many invertebrates, vertebrates, and plants live in close association to the corals, with tight resource coupling and recycling, allowing coral reefs to have extremely high productivity and biodiversity, such that they are referred to as 'the Tropical Rainforests of the Oceans'.

4.8.3. Classification and their location

- The coral reefs are classified depending on their locations into fringing, patch, barrier and atoll.
- The fringing reefs are contiguous with the shore and they are the most common - by occurring reef form, found in Andamans.
- Patch reefs are isolated and discontinuous patches, lying shoreward of offshore reef structures as seen in the Palk bay, Gulf of Mannar and Gulf of Katchchh.
- Barrier reefs are linear offshore reef structures that run parallel to coastlines and arise from submerged shelf platforms. The water body between the reef and the shore is termed as lagoon. Barrier reefs are seen in Nicobar and Lakshadweep.
- Atolls are circular or semi circular reefs that arise from subsiding sea floor platforms as coral reef building keeps ahead of subsidence. The examples are the atolls of Lakshadweep and Nicobar.
- When the reef building do not keep pace with subsidence, reefs become submerged banks as seen in Lakshadweep.
- Sea grasses grow on Kavaratti atoll, mangroves are prevalent on Andaman and Nicobar coral reefs.
- Among the four major reef areas of India, Andaman and Nicobar Islands are found to be very rich in species diversity followed by the Lakshadweep Islands, the Gulf of Mannar and finally the Gulf of Kachchh.

4.8.4. Functions of Coral Reefs

- Coral reefs are natural protective barriers against erosion and storm surge.
- The coral animals are highly adapted for capturing plankton from the water, thereby capturing nutrients
- Largest biogenic calcium carbonate producer
- They provide substrate for mangroves
- Coral reefs provide habitat for a large variety of animals and plants including avifauna.

4.8.5. Threat

1. Natural causes may be due to the outbreak of reef destroying mechanisms, "bleaching" and depletion of essential symbiotants.
2. Anthrogenic causes – may be due to chemical pollution (pesticides, cosmetics, etc), industrial pollution, mechanical damage, nutrient loading or sediment loading, Dredging, shipping, tourism, mining or collection, thermal pollution, intensive fishimg,etc.

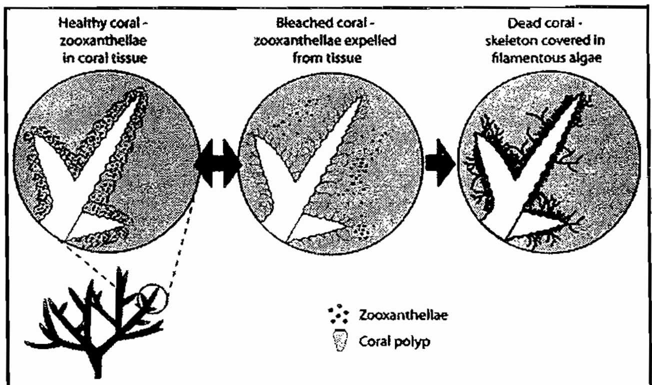
- Coral reef ecosystems world-wide have been subject to unprecedented degradation over the past few decades. Disturbances affecting coral reefs include anthropogenic and natural events. Recent accelerated coral reef decline seems to be related mostly to anthropogenic impacts (overexploitation, overfishing, increased sedimentation and nutrient overloading. Natural disturbances which cause damage to coral reefs include violent storms, flooding, high and low temperature extremes, El Nino Southern Oscillation (ENSO) events, subaerial exposures, predatory outbreaks and epizootics.
- Coral reef bleaching is a common stress response of corals to many of the various disturbances mentioned above.

4.8.6. Coral Bleaching

- Bleaching, or the paling of coral colour occurs when

(i) the densities of zooxanthellae decline and / or

(ii) the concentration of photosynthetic pigments within the zooxanthellae fall.


Healthy coral - zooxanthellae in coral tissue
Bleached coral - zooxanthellae expelled from tissue
Dead coral - skeleton covered in filamentous algae
Zooxanthellae
Coral polyp

Coral Bleaching

- When corals bleach they commonly lose 60-90% of their zooxanthellae and each zooxanthella may lose 50-80% of its photosynthetic pigments.
- If the stress-causing bleaching is not too severe and if it decreases in time, the affected corals usually regain their symbiotic algae within several weeks or a few months.
- If zooxanthellae loss is prolonged, i.e. if the stress continues and depleted zooxanthellae populations do not recover, the coral host eventually dies.
- High temperature and irradiance stressors have been implicated in the disruption of enzyme systems in zooxanthellae that offer protection against oxygen toxicity.
- Photosynthesis pathways in zooxanthallae are impaired at temperatures above 30 degrees C, this effect could activate the disassociation of coral / algal symbiosis.
- Low- or high-temperature shocks results in zooxanthellae low as a result of cell adhesion dysfunction.
- This involves the detachment of cnidarian endodermal cells with their zooxanthellae and the eventual expulsion of both cell types.

4.8.7. Ecological causes of coral bleaching

- As coral reef bleaching is a general response to stress, it can be induced by a variety of factors, alone or in combination. It is therefore difficult to unequivocally identify the causes for bleaching events. The following stressors have been implicated in coral reef bleaching events.

Temperature (Major Cause)

- Coral species live within a relatively narrow temperature margin, and anomalously low and high sea temperatures can induce coral bleaching. Bleaching is much more frequently reported from elevated sea water temperature. Bleaching events also occur during sudden temperature drops accompanying intense upwelling episodes, seasonal cold-air outbreaks.

Do you know?

All spiders produce silk but not all spiders spin webs. Silk is used for climbing, to create webs, to build smooth walls in burrows, build egg sacs, and wrap prey.

Solar Irradiance

- Bleaching during the summer months, during seasonal temperature and irradiance maxima often occurs disproportionately in shallow-living corals and on the exposed summits of colonies. Solar radiation has been suspected to play a role in coral bleaching. Both photosyntheticaly active radiation (PAR, 400-700nm) and ultraviolet radiation (UVR, 280-400nm) have been implicated in bleaching.

Subaerial Exposure

- Sudden exposure of reef flat corals to the atmosphere during events such as extreme low tides, ENSO-related sea level drops or tectonic uplift can potentially induce bleaching.

Sedimentation

- Relatively few instances of coral bleaching have been linked solely to sediment. It is possible, but has not been demonstrated, that sediment loading could make zooxanthellate species more likely to bleach.

Fresh Water Dilution

- Rapid dilution of reef waters from storm-generated precipitation and runoff has been demonstrated to cause coral reef bleaching. Generally, such bleaching events are rare and confined to relatively small, nearshore areas.

Inorganic Nutrients

- Rather than causing coral reef bleaching, an increase in ambient elemental nutrient concentrations (e.g. ammonia and nitrate) actually increases zooxanthellae densities 2-3 times. Although eutrophication is not directly involved in zooxanthellae loss, it could cause secondary adverse affects such as lowering of coral resistance and greater susceptibility to diseases.

Xenobiotics

- Zooxanthellae loss occurs during exposure of coral to elevated concentrations of various chemical contaminants, such as Cu, herbicides and oil. Because high concentrations of xenobiotics are required to induce zooxanthellae loss, bleaching from such sources is usually extremely localized and / or transitory .

Epizootics

- Pathogen induced bleaching is different from other sorts of bleaching. Most coral diseases cause patchy or whole colony death and sloughing of soft tissues, resulting in a white skeleton (not to be confused with bleached corals). A few pathogens have been identified the cause translucent white tissues, a protozoan.

4.9. KEY INITIATIVES TO PROTECT MARINE AND COASTAL ENVIRONMENTS

4.9.1. Coastal Ocean Monitoring and Prediction System (COMAPS)

- Being implemented from 1991.
- Assesses the health of coastal waters and facilitates management of pollution-related issues
- Programme was restructured and modified in 2000–2001 to include pollution monitoring; liaison, regulation and legislation; and consultancy services.

4.9.2. Land Ocean Interactions in the Coastal Zone (LOICZ)

- Launched in 1995
- Investigates the effects of global change on the coastal zone
- Aims to develop, on a scientific basis, the integrated management of coastal environments

Do you know?

Male snakes will try to attract a female by doing a type of 'play fighting' with other males to gain female attention. They do not try to kill each other just win the fight!

4.9.3. Integrated Coastal and Marine Area Management (ICMAM)

- Launched in 1998
- Aims at integrated management of coastal and marine areas.
- Model plans for Chennai, Goa and Gulf of Kutch being prepared

4.9.4. Society of Integrated Coastal Management (SICOM)

- Launched in 2010
- Major national initiative to protect coastal ecosystems
- A professional body with experts in various aspects of coastal science and management

4.9.5. Institutions for Coastal Management

- The Notification on Coastal Regulation Zone (CRZ), 1991 (as amended from time to time) aims at protecting coastal stretches in India.
- India has created institutional mechanisms such as National Coastal Zone Management Authority (NCZMA) and State Coastal Zone Management Authority (SCZMA) for enforcement and monitoring of the CRZ Notification.
- These authorities have been delegated powers under Section 5 of the Environmental (Protection) Act, 1986 to take various measures for protecting and improving the quality of the coastal environment and preventing, abating and controlling environmental pollution in coastal areas.

◆◆◆◆◆◆

CHAPTER - 5

ENVIRONMENTAL POLLUTION

Pollution is defined as 'an addition or excessive addition of certain materials to the physical environment (water, air and lands), making it less fit or unfit for life'.

5.1. POLLUTANTS

- Pollutants are the materials or factors, which cause adverse effect on the natural quality of any component of the environment.
- For example, smoke from industries and automobiles, chemicals from factories, radioactive substances from nuclear plants, sewage of houses and discarded household articles are the common pollutants.

5.1.1. Classifications

(i) According to the form in which they persist after release into the environment.

- Primary pollutants: These persist in the form in which they are added to the environment e.g. DDT, plastic.
- Secondary Pollutants: These are formed by interaction among the primary pollutants.
- For example, peroxyacetyl nitrate (PAN) is formed by the interaction of nitrogen oxides and hydrocarbons.

(ii) According to their existence in nature.

- Quantitative Pollutants: These occur in nature and become pollutant when their concentration reaches beyond a threshold level. E.g. carbon dioxide, nitrogen oxide.
- Qualitative Pollutants: These do not occur in nature and are man-made. E.g. fungicides, herbicides, DDT etc.

(iii) According to their nature of disposal.

- Biodegradable Pollutants: Waste products, which are degraded by microbial action. E.g. sewage.
- Non-biodegradable Pollutants: Pollutants, which are not decomposed by microbial action. E.g. plastics, glass, DDT, salts of heavy metals, radioactive substances etc.,)

(iv) According to origin

- Natural
- Anthropogenic

5.1.2. Causes of pollution

- Uncontrolled growth in human population
- Rapid industrialization
- Urbanization
- Uncontrolled exploitation of nature.
- Forest fires, radioactivity, volcanic eruptions, strong winds etc.,

5.2. AIR POLLUTION

- Air pollution is aggravated because of four developments: increasing traffic, growing cities, rapid economic development, and industrialization.
- 'The presence in the atmosphere of one or more contaminants in such quality and for such duration as it is injurious, or tends to be injurious, to human health or welfare, animal or plant life.'
- It is the contamination of air by the discharge of harmful substances.
- Air pollution can cause health problems, damage the environment, property and climate change.

5.2.1. Major air pollutants and their sources

Carbon monoxide (CO)

- It is a colourless, odourless gas that is produced by the incomplete burning of carbon-based fuels including petrol, diesel, and wood.
- It is also produced from the combustion of natural and synthetic products such as cigarettes.
- It lowers the amount of oxygen that enters our blood.

- It can slow our reflexes and make us confused and sleepy.

Carbon dioxide (CO_2)

- It is the principle greenhouse gas emitted as a result of human activities such as the burning of coal, oil, and natural gases.

Chloroflorocarbons (CFC)

- These are gases that are released mainly from air-conditioning systems and refrigeration.
- When released into the air, CFCs rise to the stratosphere, where they come in contact with few other gases, which lead to a reduction of the ozone layer that protects the earth from the harmful ultraviolet rays of the sun.

Lead

- It is present in petrol, diesel, lead batteries, paints, hair dye products, etc. Lead affects children in particular.
- It can cause nervous system damage and digestive problems and, in some cases, cause cancer.

Ozone

- It occurs naturally in the upper layers of the atmosphere.
- This important gas shields the earth from the harmful ultraviolet rays of the sun.
- However, at the ground level, it is a pollutant with highly toxic effects.
- Vehicles and industries are the major source of ground-level ozone emissions.
- Ozone makes our eyes itch, burn, and water. It lowers our resistance to cold and pneumonia.
- Nitrogen oxide (Nox)
- It causes smog and acid rain. It is produced from burning fuels including petrol, diesel, and coal.
- Nitrogen oxide can make children susceptible to respiratory diseases in winters.

Suspended particulate matter (SPM)

- It consists of solids in the air in the form of smoke, dust, and vapour that can remain suspended for extended periods and is also the main source of haze which reduces visibility.
- The finer of these particles, when breathed in can lodge in our lungs and cause lung damage and respiratory problems.

Sulphur dioxide (SO_2)

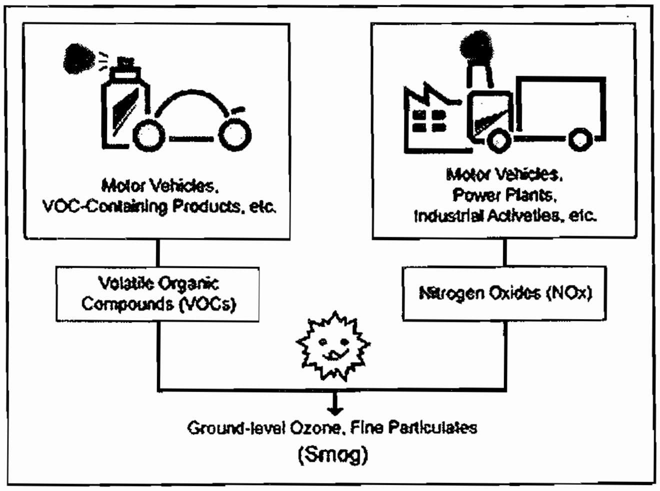
- It is a gas produced from burning coal, mainly in thermal power plants.
- Some industrial processes, such as production of paper and smelting of metals, produce sulphur dioxide.
- It is a major contributor to smog and acid rain. Sulfur dioxide can lead to lung diseases.

5.2.2. Smog

- The term smog was first used (1905) by Dr H A Des Voeux
- Smog has been coined from a combination of the words fog and smoke. Smog is a condition of fog that had soot or smoke in it.

The Formation of Smog

- Photochemical smog (smog) is a term used to describe air pollution that is a result of the interaction of sunlight with certain chemicals in the atmosphere.
- One of the primary components of photochemical smog is ozone.
- While ozone in the stratosphere protects earth from harmful UV radiation, ozone on the ground is hazardous to human health.
- Ground-level ozone is formed when vehicle emissions containing nitrogen oxides (primarily from vehicle exhaust) and volatile organic compounds (from paints, solvents, printing inks, petroleum products, vehicles, etc.) interact in the presence of sunlight.


Motor Vehicles,
VOC-Containing Products, etc.
Motor Vehicles,
Power Plants,
Industrial Activeties, etc.
Volatile Organic Compounds (VOCs)
Nitrogen Oxides (NOx)
Ground-level Ozone, Fine Particulates
(Smog)

Ground-level ozone is formed through a complex reaction involving hydrocarbons, nitrogen oxides, and sunlight. It is formed when pollutants released from gasoline, diesel-powered vehicles and oil-based solvents react with heat and sunlight.

- Smog refers to hazy air that causes difficult breathing conditions. It is a combination of various gases with water vapour and dust.
- Its occurrences are often linked to heavy traffic, high temperatures, and calm winds. During the winter, wind speeds are low and cause the smoke and fog to stagnate near the ground; hence pollution levels can increase near ground level.
- Smoke particles trapped in the fog gives it a yellow/black colour and this smog often settled over cities for many days.

The effects of smog

- It hampers visibility and harms the environment.
- respiratory problems
- deaths relating to bronchial diseases.
- Heavy smog greatly decreases ultraviolet radiation.
- Heavy smog results in the decrease of natural vitamin D production leading to a rise in the cases of rickets.

5.2.3. Indoor air pollution

- It refers to the physical, chemical, and biological characteristics of air in the indoor environment within a home, or an institution or commercial facility.
- Indoor air pollution is a concern where energy efficiency improvements sometimes make houses relatively airtight, reducing ventilation and raising pollutant levels.
- Indoor air problems can be subtle and do not always produce easily recognized impacts on health.
- Different conditions are responsible for indoor air pollution in the rural areas and the urban areas.

(a) Rural

- It is the rural areas that face the greatest threat from indoor pollution, where people rely on traditional fuels such as firewood, charcoal, and cowdung for cooking and heating.
- Burning such fuels produces large amount of smoke and other air pollutants in the confined space of the home, resulting in high exposure. Women and children are the groups most vulnerable as they spend more time indoors and are exposed to the smoke.
- Although many hundreds of separate chemical agents have been identified in the smoke from biofuels, the four most serious pollutants are particulates, carbon monoxide, polycyclic organic matter, and formaldehyde.

(b) Urban

- In urban areas, exposure to indoor air pollution has increased due to a variety of reasons, such as
- construction of more tightly sealed buildings,
- reduced ventilation,
- the use of synthetic materials for building and furnishing and
- the use of chemical products, pesticides, and household care products.
- Indoor air pollution can begin within the building or drawn in from outdoors.
- Other than nitrogen dioxide, carbon monoxide, and lead, there are a number of other pollutants that affect the air quality.

Pollutants

i) Volatile organic compounds

- The main indoor sources are perfumes, hair sprays, furniture polish, glues, air fresheners, moth repellents, wood preservatives, and other products.
- Health effect - imitation of the eye, nose and throat, headaches, nausea and loss of coordination.
- long term - suspected to damage the liver and other parts of the body.

ii) Tobacco

- Smoke generates a wide range of harmful chemicals and is carcinogenic.
- Health effect - burning eyes, nose, and throat irritation to cancer, bronchitis, severe asthma, and a decrease in lung function.

iii) Biological pollutants

- It includes pollen from plants, mite, and hair from pets, fungi, parasites, and some bacteria.

Most of them are allergens and can cause asthma, hay fever, and other allergic diseases.

iv) Formaldehyde

- Mainly from carpets, particle boards, and insulation foam. It causes irritation to the eyes and nose and allergies.

v) Radon

- It is a gas that is emitted naturally by the soil. Due to modern houses having poor ventilation, it is confined inside the house and causes lung cancers.

vi) Asbestos

vii) Pesticides

5.2.4. Fly Ash

- Ash is produced whenever combustion of solid material takes place.
- Fly ash is one such residue which rises with the gases into the atmosphere. Fly ash is a very fine powder and tends to travel far in the air. The ash which does not rise is termed as bottom ash.
- Nearly 73% of India's total installed power generation capacity is thermal, of which 90% is coal-based generation, with diesel, wind, gas, and steam making up the rest.

Composition

1. Aluminium silicate (in large amounts)
2. silicon dioxide (SiO2) and
3. Calcium oxide (CaO).

- Fly ash particles are oxide rich and consist of silica, alumina, oxides of iron, calcium, and magnesium and toxic heavy metals like lead, arsenic, cobalt, and copper.

How it is collected?

- Fly ash is generally captured by electrostatic precipitators or other particle filtration equipments before the flue gases reach the chimneys of coal-fired power plants.

Environmental effects?

- If fly ash is not captured and disposed off properly, it can pollute air and water considerably.
- It causes respiratory problems.
- Fly ash in the air slowly settles on leaves and crops in fields in areas near to thermal power plants and lowers the plant yield.

Advantages:

- Cement can be replaced by fly ash upto 35%, thus reducing the cost of construction, making roads, etc.
- Fly ash bricks are light in weight and offer high strength and durability.
- Fly ash is a better fill material for road embankments and in concrete roads.
- Fly ash can be used in reclamation of wastelands.
- Abandoned mines can be filled up with fly ash.
- Fly ash can increase the crop yield and it also enhances water holding capacity of the land .

Policy measures of MoEF:

- The Ministry of Environment and Forests vide its notification in 2009, has made it mandatory to use Fly Ash based products in all construction projects, road embankment works and low lying land filling works within 100 kms radius of Thermal Power Station.
- To use Fly Ash in mine filling activities within 50 kms radius of Thermal Power Stations.

Do you know?

- Trees are an important part of our world. They provide wood for building and pulp for making paper. They provide habitats (homes) for all sorts of insects, birds and other animals. Many types of fruits and nuts come from trees – including apples, oranges, walnuts, pears and peaches. Even the sap of trees is useful as food for insects and for making maple syrup – yum!
- Trees also help to keep our air clean and our ecosystems healthy. We breathe in oxygen and breathe out carbon dioxide. Trees breathe in carbon dioxide and breathe out oxygen. We're perfect partners!
- Trees do lots for us, our environment and other plants and animals in nature but we don't just love trees for practical reasons.

5.2.5. Effects of air pollution

- 1. health effect

Name Of Pollutant	Sources	Health Effects
Sulphur Oxides	Thermal power plants and industries	Eye and throat irritation, cough, allergies, impairs enzyme function in respiratory system. Reduces exchange of gases from lung surface.
Nitrogen Oxides	Thermal power plant, industries and vehicles	Irritation and inflammation of lungs, breathlessness, impairs enzyme function in respiratory system and causes bronchitis and asthma.
Suspended Particulate Matter (SOM)	Vehicular emissions and burning of fossil fuels	Lung irritation reduces development of RBC and cause pulmonary malfunctioning.
Carbon Monoxide	Vehicular emissions and burning of fossil fuels	Difficulty in breathing, severe headaches, irritation to mucous membrane, unconsciousness and death
Carbon Dioxide	Burning of fossil fuels	Impairs reflexes, judgment and vision, severe headaches and heart strain.
Smog	Industries and vehicular pollution	Respiratory problems and intense irritation to the eyes.
Ozone	Automobile emissions	Breathlessness, asthma, wheezing, chest pain, emphysema and chronic bronchitis.
Chlorofluorocarbons	Refrigerators, sprays, emissions from jets	Depletion of stratospheric ozone layer, global warming.
Hydrocarbons	Burning of fossil fuels	Carcinogenic effect on lungs, kidney damage, hypertension, respiratory distress, irritation of eyes, nose and throat, asthma, bronchitis and impairs enzyme function in respiratory system.
Tobacco Smoke	Cigarettes, cigars etc.	Chronic bronchitis, asthma and lung cancer, irritation of eyes, nose and throat.
Mercury	Industries	Nervous disorders, insomnia, memory loss, excitability, irritation, tremor, gingivitis and minamata disease.

Lead	Leaded petrol emissions	Damage to brain and central nervous system, kidneys and brains, impaired intelligence and interference with development of RBCs.
Cadmium	Industries	Affects the heart
Silica dust	Silicon quarries	Silicosis affects the lungs
Cotton dust	Cotton textile factories	Byssinosis involves destruction of lung tissues, chronic cough, bronchitis and emphysema.
Asbestos dust	Asbestos mining, asbestos sheet manufacturing	Asbestosis which involves severe respiratory problems and may lead to cancer.
Radioactive pollutants	Cosmic rays, x-rays, beta rays, radon and radium	Destroy living tissues and blood cells; affect cell membrane and cell enzyme functions, leukemia, and permanent genetic changes.
Coal dust and particles	Coal mines	Black lung cancer, pulmonary fibrosis which lead to respiratory failure.

II. Effects on Vegetation

- retard photosynthesis.
- Sulphur dioxide causes chlorosis, plasmolysis, membrane damage and metabolic inhibition.
- Hydrocarbons such as ethylene cause premature leaf fall, fruit drop, shedding of floral buds, curling of petals and discoloration of sepals.
- Ozone damage chlorenchyma and thus destructs the foliage in large number of plants.

III. Effects on Animals

IV. Detoriation of materials

V. Aesthetic Loss

5.2.6. Control Measures

1. Policy measures
2. Preventive measures:

- Selection of suitable fuel (e.g.fuel with low sulphur content) and its efficient utilization
- Modifications in industrial processes and/or equipments to reduce emission.
- Selection of suitable manufacturing site and zoning. e.g. setting of industries at a distance of residential areas, installation of tall chimneys.

Control measures:

(i) destroying the pollutants by thermal or catalytic combustion

(ii) conversion of the pollutants to a less toxic form

(iii) collection of the pollutant

- Different types of air pollutants can be eliminated / minimised by following methods:

a) Control of particulate matter: Two types of devices - arresters and scrubbers are used to remove particulate pollutants from air. These are arresters and scrubbers.

   i. Arresters: These are used to separate particulate matters from contaminated air.

   ii. Scrubbers: These are used to clean air for both dusts and gases by passing it through a dry or wet packing material.

b) Control of Gaseous Pollutants:

The gaseous pollutants can be controlled through the techniques of Combustion, absorption and adsorption.

c) Control of Automobile Exhaust

   i. use of efficient engines (e.g. multipoint fuel injection engine).

   ii. Catalytic converter filters in the vehicles can convert nitrogen oxide to nitrogen and reduce the potential hazards of NOx.

   iii. use of good quality automobile fuels

   iv. use of lead free petrol.

   v. Use of compressed natural gas (CNG).

5.2.7. Government Initiatives

(1) National Air Quality Monitoring Programme

- In India, the Central Pollution Control Board (CPCB) has been executing a nationwide programme of ambient air quality monitoring known as National Air Quality Monitoring Programme (NAMP).
- The National Air Quality Monitoring Programme (NAMP) is undertaken in India
  - (i) to determine status and trends of ambient air quality;
  - (ii) to ascertain the compliance of NAAQS;
  - (iii) to identify non-attainment cities;
  - (iv) to understand the natural process of cleaning in the atmosphere; and
  - (v) to undertake preventive and corrective measures.
- Annual average concentration of SOx levels are within the prescribed National Ambient Air Quality Standards (NAAQS).
- This reduction from earlier levels is due to various measures taken, including the use of CNG in public transport in Delhi, the reduction of sulphur in diesel and use of LPG instead of coal as a domestic fuel.
- A mixed trend is observed in NO2 levels due to various measures taken for vehicular pollution control, such as stricter vehicular emission norms being partially offset by increased NOx levels due to the use of CNG in urban transport.
- Total suspended particulates, however, are still a matter of concern in several urban and semi urban areas.

(b) National Ambient Air Quality Standards (NAAQS)

- National Ambient Air Quality Standards (NAAQS) were notified in the year 1982, duly revised in 1994 based on health criteria and land uses.
- The NAAQS have been revisited and revised in November 2009 for 12 pollutants, which include

1. sulphur dioxide (SO_2),
2. nitrogen dioxide (NO_2),
3. particulate matter having size less than 10 micron (PM10),
4. particulate matter having size less than 2.5 micron (PM2.5),
5. ozone,
6. lead,
7. carbon monoxide (CO),
8. arsenic,
9. nickel,
10. benzene,
11. ammonia, and
12. benzopyrene.

5.3. WATER POLLUTION

- 'Addition of certain substances to the water such as organic, inorganic, biological, radiological, heat, which degrades the quality of water so that it becomes unfit for use'. Water pollution is not only confined to surface water, but it has also spread to ground water, sea and ocean.

5.3.1. Sources

Types of sources

1. Point Sources

- It is directly attributable to one influence. Here pollutant travels directly from source to water. Point sources are easy to regulate.

2. Diffuse or non-point source.

- It is from various ill defined and diffuse sources. They vary spatially and temporally and are difficult to regulate.
- The main sources of water pollution are as follows:

1) Community waste water: include discharges from houses, commercial and industrial establishments connected to public sewerage system. The sewage contains human and animal excreta, food residues, cleaning agents, detergents and other wastes.

> Putrescibility is the process of decomposition of organic matter present in water by microorganisms using oxygen.

2) Industrial Wastes: The industries discharge several inorganic and organic pollutants, which may prove highly toxic to the living beings.

Type of Industry	Inorganic pollutants	Organic pollutant
Mining	Mine Wastes: Chlorides, various metals, ferrous sulphate, sulphuric acid, hydrogen sulphide, ferric hydroxide, surface wash offs, suspended solids, chlorides and heavy metals.	
Iron and Steel	Suspended solids, iron cyanide, thiocyanate, sulphides, oxides of copper, chromium, cadmium, and mercury.	Oil, phenol and neptha
Chemical Plants	Various acids and alkalies, chlorides, sulphates, nitrates of metals, phosphorus, fluorine, silica and suspended particles.	Aromatic compounds solvents, organic acids, nitro compound dyes, etc.
Pharmaceutical	-	Proteins, carbohydrates, organic solvent intermediate products, drugs and antibiotics
Soap and Detergent	Tertiary ammonium compounds alkalies	Flats and fatty acids, glycerol, polyphosphates, sulphonated hydrocarbons.
Food processing	-	Highly putrescible organic matter and pathogens
Paper and Pulp	Sulphides, bleaching liquors.	Cellulose fibres, bark, woods sugars organic acids.

3) Agricultural sources:

- Fertilizers contain major plant nutrients such as nitrogen, phosphorus and potassium.
- Excess fertilizers may reach the ground water by leaching or may be mixed with surface water of rivers, lakes and ponds by runoff and drainage.
- Pesticides include insecticides, fungicides, herbicides, nematicides, rodenticides and soil fumigants.
- They contain a wide range of chemicals such as chlorinated hydrocarbons, organophosphates, metallic salts, carbonates, thiocarbonates, derivatives of acetic acid etc. Many of the pesticides are non-degradable and their residues have long life.
- The animal excreta such as dung, wastes from poultry farms, piggeries and slaughter houses etc. reach the water though run off and surface leaching during rainy season.

4) Thermal Pollution:

- The main sources are the thermal and nuclear power plants. The power plants use water as coolant and release hot waters to the original source. Sudden rise in temperature kills fishes and other aquatic animals.

5) Underground water pollution:

- In India at many places, the ground water is threatened with contamination due to seepage from industrial and municipal wastes and effluents, sewage channels and agricultural runoff.

6) Marine pollution:

- Oceans are the ultimate sink of all natural and manmade pollutants. Rivers discharge their pollutants into the sea. The sewerage and garbage of coastal cities are also dumped into the sea. The other sources of oceanic pollution are navigational discharge of oil, grease, detergents, sewage, garbage and radioactive wastes, off shore oil mining, oil spills.

Oil Spills

- Oil spills is one of the most dangerous of all water pollutants.
- Oil spills from tankers at sea or leaks from underground storage tanks on land are very difficult to control as oil tends to spread very fast, affecting a large area in a very short time.
- On land crude is transported through pipelines or tankers which can get damaged and spew out crude oil over the land, thereby contaminating it.
- Since crude oil is lighter than water, it floats on the surface and poses the threat of swift-spreading fire.
- Oil spills at sea decrease the oxygen level in the water and cause harm to the organisms.
- Oil spills are also a source of air and groundwater pollution.

5.3.2. Effects of Water Pollution

1. Effects on aquatic ecosystem:

i) Polluted water reduces Dissolved Oxygen (DO) content, thereby, eliminates sensitive organisms like plankton, molluscs and fish etc.

However a few tolerant species like Tubifex (annelid worm) and some insect larvae may survive in highly polluted water with low DO content. Such species are recognised as indicator species for polluted water.

ii) Biocides, polychlorinated biphenyls (PCBs) and heavy metals directly eliminate sensitive aquatic organisms.

iii) Hot waters discharged from industries, when added to water bodies, lowers its DO content.

Do you know?

The Environmental Performance Index, is conducted and written by environmental research centers at Yale and Columbia universities with assistance from outside scientists.

Different parts of the tree grow at different times of the year. A typical pattern is for most of the foliage growth to occur in the spring, followed by trunk growth in the summer and root growth in the fall and winter. Not all the trees follow the same pattern.

DO , BOD, COD

- Presence of organic and inorganic wastes in water decreases the dissolved Oxygen (DO) content of the water. Water having DO content below 8.0 mg L-1 may be considered as contaminated. Water having DO content below. 4.0 mg L-1 is considered to be highly polluted. DO content of water is important for the survival of aquatic organisms. A number of factors like surface turbulence, photosynthetic activity, O2 consumption by organisms and decomposition of organic matter are the factors which determine the amount of DO present in water.
- The higher amounts of waste increases the rates of decomposition and O2 consumption, thereby decreases the DO content of water. The demand for O2 is directly related to increasing input of organic wastes and is empressed as biological oxygen demand (BOD) of water.
- Water pollution by organic wastes is measured in terms of Biochemical Oxygen Demand (BOD). BOD is the amount of dissolved oxygen needed by bacteria in decomposing the organic wastes present in water. It is expressed in milligrams of oxygen per litre of water.
- The higher value of BOD indicates low DO content of water. Since BOD is limited to biodegradable materials only. Therefore, it is not a reliable method of measuring pollution load in water.
- Chemical oxygen demand (COD) is a slightly better mode used to measure pollution load in water. It is the measure of oxygen equivalent of the requirement of oxidation of total organic matter (i.e. biodegradable and non-biodegradable) present in water.

2. Effects on human health:

- The polluted water usually contains pathogens like virus, bacteria, parasitic protozoa and worms, therefore, it is a source of water borne diseases like jaundice, cholera, typhoid, amoebiasis etc.
- Mercury compounds in waste water are converted by bacterial action into extremely toxic methyl mercury, which can cause numbness of limbs, lips and tongue, deafness, blurring of vision and mental derangement.

A cripling deformity called Minamata disease due to consumption of fish captured from mercury contaminated Minamata Bay in Japan was detected in 1952.

- Water contaminated with cadmium can cause itai itai disease also called ouch-ouch disease (a painful disease of bones and joints) and cancer of lungs and liver.
- The compounds of lead cause anaemia, headache, loss of muscle power and bluish line around the gum.

3. **Hazards of ground water pollution:**

i. Presence of excess nitrate in drinking water is dangerous for human health and may be fatal for infants.

- Excess nitrate in drinking water reacts with hemoglobin to form non-functional methaemoglobin, and impairs oxygen transport. This condition is called methaemoglobinemia or blue baby syndrome.

ii. Excess fluoride in drinking water causes neuro-muscular disorders, gastro-intestinal problems, teeth deformity, hardening of bones and stiff and painful joints (skeletal fluorosis).

- High concentration of fluoride ions is present in drinking water in 13 states of India. The maximum level of fluoride, which the human body can tolerate is 1.5 parts per million (mg/1 of water). Long term ingestion of fluoride ions causes fluorosis.

iii. Over exploitation of ground water may lead to leaching of arsenic from soil and rock sources and contaminate ground water. Chronic exposure to arsenic causes black foot disease. It also causes diarrhoea, peripheral neuritis, hyperkerotosis and also lung and skin cancer.

- Arsenic contamination is a serious problem (in tube well dug areas) in the Ganges Delta, west bengal causing serious arsenic poisoning to large numbers of people. A 2007 study found that over 137 million people in more than 70 countries are probably affected by arsenic poisoning of drinking water.

4. Biological Magnification
5. Eutrophicaiton

5.3.3. Control Measures

1) Riparian buffers
2) Treatment of sewage water and the industrial effluents should be done before releasing it into water bodies.
3) Hot water should be cooled before release from the power plants
4) Domestic cleaning in tanks, streams and rivers, which supply drinking water, should be prohibited.
5) Excessive use of fertilizers and pesticides should be avoided.
6) Organic farming and efficient use of animal residues as fertilizers.
7) Water hyacinth (an aquatic weed) can purify water by taking some toxic materials and a number of heavy metals from water.
8) Oil spills in water can be cleaned with the help of bregoli – a by-product of paper industry resembling saw dust, oil zapper, micro-organisms.

5.4. SOIL POLLUTION

- Soil is a thin layer of organic and inorganic materials that covers the Earth's rocky surface. Soil pollution is defined as the 'addition of substances to the soil, which adversely affect physical, chemical and biological properties of soil and reduces its productivity.'
- It is build-up of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents in soil which have adverse effects on plant growth, human and animal health.
- A soil pollutant is any factor which deteriorates the quality, texture and mineral content of the soil or which disturbs the biological balance of the organisms in the soil.

5.4.1. Causes

- Indiscriminate use of fertilizers, pesticides, insecticides and herbicides
- Dumping of large quantities of solid waste
- Deforestation and soil erosion.
- Pollution Due to Urbanisation

5.4.2. Source

i. **Industrial Wastes:**

- Industrial waste includes chemicals such as mercury, lead, copper, zinc, cadmium, cynides, thiocynates, chromates, acids, alkalies, organic substances etc.

ii. Pesticides:

- ➢ Pesticides are chemicals that include insecticides, fungicides, algicides, rodenticides, weedicides sprayed in order to improve productivity of agriculture, forestry and horticulture.

iii. Fertilizers and manures:

- ➢ Chemical fertilizers are added to the soil for increasing crop yield. Excessive use of chemical fertilizers reduces th e population of soil borne organism and the crumb structure of the soil, productivity of the soil and increases salt content of the soil.

iv. Discarded materials:

- ➢ It includes concrete, asphalt, rungs, leather, cans, plastics, glass, discarded food, paper and carcasses.

v. Radioactive wastes:

- ➢ Radioactive elements from mining and nuclear power plants, find their way into water and then into the soil.

vi. Other pollutants:

- ➢ Many air pollutants (acid rain) and water pollutants ultimately become part of the soil and the soil also receives some toxic chemicals during weathering of certain rocks. [in box]

5.4.3. Types of Soil Pollution

I. Agricultural Soil Pollution
II. Pollution due to industrial effluents and solid wastes
III. Pollution due to urban activities

5.4.4. Effects of soil pollution on

i) Agriculture
- Reduced soil fertility
- Reduced nitrogen fixation
- Increased erosion
- Loss of soil and nutrients
- Reduced crop yield
- Increased salinity
- Deposition of silt in tanks and reservoirs

ii) Health
- Dangerous chemicals entering underground water
- Bio magnification
- Release of pollutant gases
- Release of radioactive rays causing health problems

iii) Environment
- Reduced vegetation
- Ecological imbalance
- Imbalance in soil fauna and flora

iv) Urban areas
- Clogging of drains
- Inundation of areas
- Foul smell and release of gases
- Waste management problems

➢ Control measures
- Reducing chemical fertilizer and pesticide use
- Use of bio pesticides, bio fertilizers.
- Organic farming
- Four R's: Refuse, Reduce, Reuse, and Recycle
- Afforestation and Reforestation
- Solid waste treatment
- Reduction of waste from construction areas

FOUR R'S

1. Refuse

- ➢ Instead of buying new containers from the market, use the ones that are in the house. Refuse to buy new items though you may think they are prettier than the ones you already have.

2. Reuse

- ➢ Do not throw away the soft drink cans or the bottles; cover them with homemade paper or paint on them and use them as pencil stands or small vases.

3. Recycle

- ➢ Use shopping bags made of cloth or jute, which can be used over and over again. Segregate your waste to make sure that it is collected and taken for recycling.

4. Reduce

- ➢ Reduce the generation of unnecessary waste, e.g. carry your own shopping bag when you go to the market and put all your purchases directly into it.

5.5. NOISE POLLUTION

- Noise pollution is an unpleasant noise created by people or machines that can be annoying, distracting, intrusive, and/or physically painful.
- Noise pollution comes from sources such as "road traffic, jet planes, garbage trucks, construction equipment, manufacturing processes, leaf blowers, and boom boxes."
- Sound is measured in decibels (dB). An increase of about 10 dB is approximately double the increase in loudness.
- A person's hearing can be damaged if exposed to noise levels over 75 dB over a prolonged period of time. The World Health Organization recommends that the sound level indoors should be less than 30 dB.

5.5.1. Ambient Noise Level Monitoring

- Noise Pollution (Control and Regulation) Rules, 2000 define ambient noise levels for various areas as follows:

Category of Area/ Zone	Limits in dB(A) Leq	
	Day Time	Night Time
	6 a.m. to 10 p.m.	10 p.m to 6 a.m
A. Industrial Area	75	70
B. Commercial Area	65	55
C. Residential Area	55	45
D. Silence Zone	50	40

- The Government of India on Mar 2011 launched a Real time Ambient Noise Monitoring Network. Under this network, in phase- I, five Remote Noise Monitoring Terminals each have been installed in different noise zones in seven metros (Delhi, Hyderabad, Kolkata, Mumbai, Bangalore, Chennai and Lucknow).
- In Phase II another 35 monitoring stations will be installed in the same seven cities. Phase III will cover installing 90 stations in 18 other cities.
- Phase-III cities are Kanpur, Pune, Surat, Ahmedabad, Nagpur, Jaipur, Indore, Bhopal, Ludhiana, Guwahati, Dehradun, Thiruvananthpuram, Bhubaneswar, Patna, Gandhinagar, Ranchi, Amritsar and Raipur.
- Silence Zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area declared as such by a competent authority.

5.5.2. Impacts of noise

- Annoyance: It creates annoyance to the receptors due to sound level fluctuations. The a-periodic sound due to its irregular occurrences causes displeasure to hearing and causes annoyance.
- Physiological effects: The physiological features like breathing amplitude, blood pressure, heart-beat rate, pulse rate, blood cholesterol are affected.
- Loss of hearing: Long exposure to high sound levels cause loss of hearing. This is mostly unnoticed, but has an adverse impact on hearing function.
- Human performance: The working performance of workers/human will be affected as it distracts the concentration.
- Nervous system: It causes pain, ringing in the ears, feeling of tiredness, thereby effecting the functioning of human system.
- Sleeplessness: It affects the sleeping there by inducing people to become restless and loose concentration and presence of mind during their activities
- Damage to material : The buildings and materials may get damaged by exposure to infrasonic / ultrasonic waves and even get collapsed.

5.5.3. Control

- The techniques employed for noise control can be broadly classified as

1. Control at source

- Reducing the noise levels from domestic sectors
- Maintenance of automobiles
- Control over vibration
- Prohibition on usage of loud speakers
- Selection and maintenance of machinery

2. Control in the transmission path

- Installation of barriers
- Design of building
- Green belt development (planting of trees)

3. Using protective equipment.

- Job rotation
- Reduced Exposure time
- Hearing protection

- Documentation of noise measurements, continuous monitoring and awareness are the need of the hour.

5.6. RADIO ACTIVE POLLUTION

5.6.1. Radioactive Pollution

- Radioactivity is a phenomenon of spontaneous emission of proton (a-particles), electrons (ß-particles) and gamma rays (short wave electromagnetic waves) due to disintegration of atomic nuclei of some elements. These cause radioactive pollution.

Radioactivity:

Radioactivity is a property of certain elements (radium, thorium, uranium etc.) to spontaneously emit protons (alpha particles) electrons (beta particles) and gamma rays (short-wave electromagnetic wave) by disintegration of their atomic nuclei (nuclides).

5.6.2. Types of Radiations

1. Non-ionising radiations affect only those components which absorb them and have low penetrability.
2. Ionising radiations have high penetration power and cause breakage of macro molecules.

5.6.3. Types of radiation particles

1. Alpha particles, can be blocked by a piece of paper and human skin.
2. Beta particles can penetrate through skin, while can be blocked by some pieces of glass and metal.
3. Gamma rays can penetrate easily to human skin and damage cells on its way through, reaching far, and can only be blocked by a very thick, strong, massive piece of concrete.

5.6.4. Sources

Natural

- They include cosmic rays from space and terrestrial radiations from radio-nuclides present in earth's crust such as radium-224, uranium-238, thorium-232, potassium-40, carbon-14, etc.

Man – made

- Nuclear power plants
- Nuclear weapon
- Transportation of nuclear material
- Disposal of nuclear waste
- Uranium mining
- Radiation therapy

Atomic explosion (Nuclear fallout):

- The nuclear arms use uranium-235 and plutonium-239 for fission and hydrogen or lithium as fusion material. Atomic explosions produce radioactive particles that are thrown high up into the air as huge clouds. These particles are carried to long distances by wind and gradually settle over the earth as fall out or are brought down by rain. The fall out contains radioactive substances such as strontium-90, cesium-137, iodine – 131, etc.

5.6.5. Effects

- The effects of radioactive pollutants depend upon

i. half-life

ii. energy releasing capacity

iii. rate of diffusion and

iv. rate of deposition of the pollutant.

v. Various environmental factors such as wind, temperature, rainfall also influence their effects.

Period of Radioactivity

- Each radioactive nuclide has a constant decay rate. Half-life is the time needed for half of its atoms to decay. Half-life of a radio nuclide refers to its period of radioactivity. The half-life may vary from a fraction of a second to thousands of years. The radio nuclides with long half-time are the chief source of environmental radioactive pollution.

- Radiations are of two types with regard to the mode of their action on cells.

1. Non-ionising radiations:

- They include short-wave radiations such as ultraviolet rays, which forms a part of solar radiation.
- They have low penetrating power and affect the cells and molecules which absorb them.
- They damage eyes which may be caused by reflections from coastal sand, snow (snow blindness) directly looking towards sun during eclipse.

- They injure the cells of skin and blood capillaries producing blisters and reddening called sunburns.

2. Ionising radiations.

- They include X-rays, cosmic rays and atomic radiations (radiations emitted by radioactive elements).
- Ionising radiations have high penetration power and cause breakage of macro molecules.
- The molecular damage may produce short range (immediate) or long range (delayed) effects.
  - i. Short range effects include burns, impaired metabolism, dead tissues and death of the organisms.
  - ii. Long range effects are mutations increased incidence of tumors and cancer, shortening of life-span and developmental changes.
  - iii. The mutated gene can persist in living organisms and may affect their progeny.
- The actively dividing cells such as Embryo, foetus, cells of skin, intestinal lining, bone marrow and gamete forming cells are more sensitive to radiations.
- Some species of animals and plants preferentially accumulate specific radioactive materials. For example, oysters deposit 65Zn, fish accumulate 55Fe, marine animals selectively deposit 90Sr.

5.6.6. Control Measures

- Prevention is the best control measure as there is no cure available for radiation damage.
  - i. All safety measures should be strictly enforced. Leakage of radioactive elements should be totally checked.
  - ii. Safe disposal of radioactive waste.
  - iii. Regular monitoring through frequent sampling and quantitative analysis.
  - iv. Safety measures against nuclear accidents.
  - v. Nuclear explosions and use of nuclear weapons should be completely banned.
  - vi. Appropriate steps should be taken to protect from occupational exposure.

5.7. E – WASTE

- The discarded and end-of-life electronic products ranging from computers, equipment used in Information and Communication Technology (ICT), home appliances, audio and video products and all of their peripherals are popularly known as Electronic waste (E-waste).
- E-waste is not hazardous if it is stocked in safe storage or recycled by scientific methods or transported from one place to the other in parts or in totality in the formal sector. The e-waste can, however, be considered hazardous if recycled by primitive methods.

5.7.1. Source and its health effects

S.NO	PARTICULARS	SOURCE	HEALTH EFFECTS
1.	Lead	Used in glass panels and gaskets in computer monitors Solder in printed circuit boards and other Components	Lead causes damage to the central and peripheral nervous systems, blood systems, kidney and reproductive system in humans. It also effects the endocrine system, and impedes brain development among children. Lead tends to accumulate in the environment and has high acute and chronic effects on plants, animals and microorganisms.
2.	Cadmium	Occurs in SMD chip resistors, infra-red detectors, and semiconductor chips Some older cathode ray tubes contain cadmium	Toxic cadmium compounds accumulate in the human body, especially the kidneys.

Do you know?

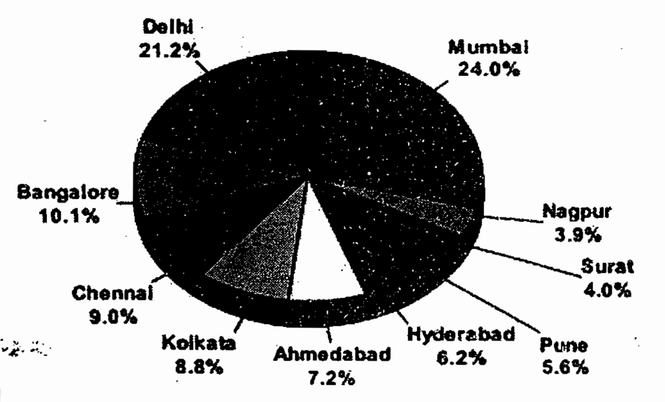
Diesel engine exhaust fumes can cause cancer in humans and it belong in the same potentially deadly category as asbestos, arsenic and mustard gas - World Health Organization (WHO) (June, 2012).

3.	Mercury	It is estimated that 22 % of the yearly world consumption of mercury is used in electrical and electronic equipment Mercury is used in thermostats, sensors, relays, switches, medical equipment, lamps, mobile phones and in batteries Mercury, used in flat panel displays, will likely increase as their use replaces cathode ray tubes	Mercury can cause damage to organs including the brain and kidneys, as well as the foetus. The developing foetus is highly vulnerable to mercury exposure. When inorganic mercury spreads out in the water, it is transformed to methylated mercury which bio-accumulates in living organisms and concentrates through the food chain, particularly via fish.
4.	Hexavalent Chromium/ Chromium VI 29	Chromium VI is used as corrosion protector of untreated and galvanized steel plates and as a decorative or hardener for steel housings Plastics (including PVC): Dioxin is released when PVC is burned. The largest volume of plastics (26%) used in electronics has been PVC. PVC elements are found in cabling and computer housings. Many computer moldings are now made with the somewhat more benign ABS plastics	Chromium VI can cause damage to DNA and is extremely toxic in the environment.
5.	Brominated flame retardants (BFRs):	BFRs are used in the plastic housings of electronic equipment and in circuit boards to prevent flammability	
6.	Barium	Barium is a soft silvery-white metal that is used in computers in the front panel of a CRT, to protect users from radiation	Studies have shown that short-term exposure to barium causes brain swelling, muscle weakness, damage to the heart, liver, and spleen.
7.	Beryllium	Beryllium is commonly found on motherboards and finger clips It is used as a copper-beryllium alloy to strengthen connectors and tinyplugs while maintaining electrical conductivity	Exposure to beryllium can cause lung cancer. Beryllium also causes a skin disease that is characterised by poor wound healing and wartlike bumps. Studies have shown that people can develop beryllium disease many years following the last exposure.

8.	Toners	Found in the plastic printer cartridge containing black and color toners.	Inhalation is the primary exposure pathway, and acute exposure may lead to respiratory tract irritation. Carbon black has been classified as a class 2B carcinogen, possibly carcinogenic to humans. Reports indicate that colour toners (cyan, magenta and yellow) contain heavy metals.
9.	Phosphor and additives	Phosphor is an inorganic chemical compound that is applied as a coat on the interior of the CRT faceplate.	The phosphor coating on cathode ray tubes contains heavy metals, such as cadmium, and other rare earth metals, for example, zinc, vanadium as additives. These metals and their compounds are very toxic. This is a serious hazard posed for those who dismantle CRTs by hand.

5.7.2. E – Waste in India

- Survey was carried out by the Central Pollution Control Board (CPCB) during 2005 estimated that 1.347 lakh MT of e-waste was generated in the country in the year 2005, which is expected to increase to about 8.0 lakh MT by 2012.
- In India, among top ten cities, Mumbai ranks first in generating e-waste followed by Delhi, Bangalore, Chennai, Kolkata, Ahmadabad, Hyderabad, Pune, Surat and Nagpur.

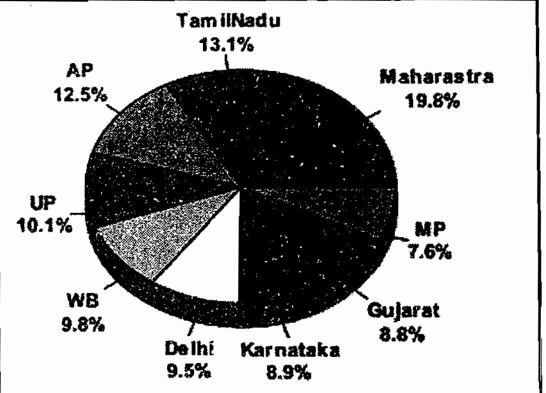


City wise E-waste Generation in India(Tonnes/year)

Do you know?

The sex of crocodilians is determined by the incubation conditions, particularly the temperature. Incubation at 30°C or less gives exclusively females, incubation at around 31°C gives both sexes, whereas incubation between 32°C and 33°C gives mostly males. Incubation at temperatures above 33°C gives males in some species, whereas in others, the sex reverts to females

- The 65 cities generate more than 60% of the total generated ewaste, whereas, 10 states generate 70% of the total e-waste.



State wise E-waste Generation in India (Tonnes/year)

- Most of the e-waste is recycled in India in unorganized units, which engage significant number of manpower. Recovery of metals by primitive means is a most hazardous act.
- The recycling process, if not carried out properly, can cause damage to human being through inhalation of gases during recycling, contact of the skin with hazardous substances and contact during acid treatment used in recovery process.
- Proper education, awareness and most importantly alternative cost effective technology need to be provided so that better means can be provided to those who earn the livelihood from this.
- A holistic approach is needed to address the challenges faced by India in e-waste management. A suitable mechanism needs to be evolved to include small units in unorganized sector and large units in organized sector into a single value chain.

5.8. SOLID WASTE

- Solid wastes are the discarded (abandoned or considered waste-like) materials. Solid waste means any garbage, refuse, sludge from a wastewater treatment plant, or air pollution control facility and other discarded materials including solid, liquid, semi-solid, or contained gaseous material, resulting from industrial, commercial, mining and agricultural operations, and from community activities. But it does not include solid or dissolved materials in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges.

5.8.1. Plastic Waste

- Plastics are considered to be one of the wonderful inventions of 20th Century. They are widely used as packing and carry bags because of cost and convenience. But plastics are now considered as environmental hazard due to the "Throw away culture".

5.8.2. Source of generation of waste plastics

- Household
- Health and medicare
- Hotel and catering
- Air/rail travel

5.8.3. Effects

- The land gets littered by plastic bag garbage and becomes ugly and unhygienic.
- Conventional plastics have been associated with reproductive problems in both humans and wildlife.
- Dioxin (highly carcinogenic and toxic) by-product of the manufacturing process is one of the chemicals believed to be passed on through breast milk to the nursing infant.
- Burning of plastics, especially PVC releases this dioxin and also furan into the atmosphere. Thus, conventional plastics, right from their manufacture to their disposal are a major problem to the environment.
- Plastic bags can also contaminate foodstuffs due to leaching of toxic dyes and transfer of pathogens.
- Careless disposal of plastic bags chokes drains, blocks the porosity of the soil and causes problems for groundwater recharge.
- Plastic disturbs the soil microbe activity. The terrestrial and aquatic animals misunderstand plastic garbage as food items, swallow them and die.
- Plastic bags deteriorates soil fertility as it forms part of manure and remains in the soil for years.
- These bags finding their way in to the city drainage system results in blockage causing inconvenience, difficult in maintenance, creates unhygienic environment resulting in health hazard and spreading of water borne diseases.
- Designing eco-friendly, biodegradable plastics are the need of the hour.

5.8.4. Types

- Solid wastes are classified depending on their source:

a) Municipal waste,

b) Hazardous waste and

c) Biomedical waste or hospital waste.

a) Municipal solid waste

- Municipal solid waste consists of household waste, construction and demolition debris, sanitation residue, and waste from streets.
- With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition changing.
- In 1947 cities and towns in India generated an estimated 6 million tonnes of solid waste, in 1997 it was about 48 million tonnes. More than 25% of the municipal solid waste is not collected at all.
- 70% of the Indian cities lack adequate capacity to transport it and there are no sanitary landfills to dispose of the waste. The existing landfills are neither well equipped and are not lined properly to protect against contamination of soil and groundwater.
- Over the last few years, the consumer market has grown rapidly leading to products being packed in cans, aluminium foils, plastics, and other such nonbiodegradable items that cause incalculable harm to the environment.

b) Hazardous waste

- Industrial and hospital waste is considered hazardous as they contain toxic substances. Hazardous wastes could be highly toxic to humans, animals, and plants and are corrosive, highly inflammable, or explosive.

- India generates around 7 million tonnes of hazardous wastes every year, most of which is concentrated in four states: Andhra Pradesh, Bihar, Uttar Pradesh, and Tamil Nadu.
- Household waste that can be categorized as hazardous waste include old batteries, shoe polish, paint tins, old medicines, and medicine bottles.
- In the industrial sector, the major generators of hazardous waste are the metal, chemical, paper, pesticide, dye, refining, and rubber goods industries.
- Direct exposure to chemicals in hazardous waste such as mercury and cyanide can be fatal.

c. Hospital waste

- Hospital waste is generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities or in the production or testing of biologicals.
- These chemicals include formaldehyde and phenols, which are used as disinfectants, and mercury, which is used in thermometers or equipment that measure blood pressure.
- It may include wastes like soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, disposable syringes, swabs, bandages, body fluids, human excreta, etc.
- These are highly infectious and can be a serious threat to human health if not managed in a scientific and discriminate manner.
- Surveys carried out by various agencies show that the health care establishments in India are not giving due attention to their waste management.
- After the notification of the Bio-medical Waste (Handling and Management) Rules, 1998, these establishments are slowly streamlining the process of waste segregation, collection, treatment, and disposal.

5.7.5. Treatment and disposal of solid waste

i) Open dumps

- Open dumps refer to uncovered areas that are used to dump solid waste of all kinds. The waste is untreated, uncovered, and not segregated. It is the breeding ground for flies, rats, and other insects that spread disease. The rainwater run-off from these dumps contaminates nearby land and water thereby spreading disease. Treatment by open dumps is to be phased out.

ii) Landfills

- Landfills are generally located in urban areas. It is a pit that is dug in the ground. The garbage is dumped and the pit is covered with soil everyday thus preventing the breeding of flies and rats. Thus, every day, garbage is dumped and sealed. After the landfill is full, the area is covered with a thick layer of mud and the site can thereafter be developed as a parking lot or a park.
- Problems - All types of waste are dumped in landfills and when water seeps through them it gets contaminated and in turn pollutes the surrounding area. This contamination of groundwater and soil through landfills is known as leaching.

iii) Sanitary landfills

- Sanitary landfill is more hygienic and built in a methodical manner to solve the problem of leaching. These are lined with materials that are impermeable such as plastics and clay, and are also built over impermeable soil. Constructing sanitary landfills is very costly

iv) Incineration plants

- The process of burning waste in large furnaces at high temperature is known as incineration. In these plants the recyclable material is segregated and the rest of the material is burnt and ash is produced.
- Burning garbage is not a clean process as it produces tonnes of toxic ash and pollutes the air and water. A large amount of the waste that is burnt here can be recovered and recycled. In fact, at present, incineration is kept as the last resort and is used mainly for treating the infectious waste.

v) Pyrolysis

- It is a process of combustion in absence of oxygen or the material burnt under controlled atmosphere of oxygen. It is an alternative to incineration. The gas and liquid thus obtained can be used as fuels. Pyrolysis of carbonaceous wastes like firewood, coconut, palm waste, corn combs, cashew shell, rice husk paddy straw and saw dust, yields charcoal along with products like tar, methyl alcohol, acetic acid, acetone and a fuel gas.

vi) Composting

- Composting is a biological process in which micro-organisms, mainly fungi and bacteria, decompose degradable organic waste into humus like substance in the presence of oxygen.
- This finished product, which looks like soil, is high in carbon and nitrogen and is an excellent medium for growing plants.
- It increases the soil's ability to hold water and makes the soil easier to cultivate. It helps the soil retain more plant nutrients.
- It recycles the nutrients and returns them back to soil as nutrients.
- Apart from being clean, cheap, and safe, composting can significantly reduce the amount of disposable garbage.

vii) Vermiculture

- It is also known as earthworm farming. In this method, Earth worms are added to the compost. These worms break the waste and the added excreta of the worms makes the compost very rich in nutrients.

viii) Four R's

5.7.6. Waste Minimization Circles (WMC)

WMC helps Small and Medium Industrial Clusters in waste minimization in their industrial plants.

- This is assisted by the World Bank with the Ministry of Environment and Forests acting as the nodal ministry. The project is being implemented with the assistance of National Productivity Council (NPC), New Delhi.
- The initiative also aims to realize the objectives of the Policy Statement for Abatement of Pollution (1992), which states that the government should educate citizens about environmental risks, the economic and health dangers of resource degradation and the real economic cost of natural resources.
- The policy also recognizes that citizens and non-governmental organizations play a role in environmental monitoring, therefore, enabling them to supplement the regulatory system and recognizing their expertise where such exists and where their commitments and vigilance would be cost effective.

5.8. BIOREMEDIATION

- Bioremediation is the use of microorganisms (bacteria and fungi) to degrade the environmental contaminants into less toxic forms.
- The microorganisms may be indigenous to a contaminated area or they may be isolated from elsewhere and brought to the contaminated site.

The process of bioremediation can be monitored indirectly by measuring the Oxidation Reduction Potential or redox in soil and groundwater, together with pH, temperature, oxygen content, electron acceptor/donor concentrations, and concentration of breakdown products (e.g. carbon dioxide)

5.8.1. Bioremediation Strategies

(a) In situ bioremediation techniques

- It involves treatment of the contaminated material at the site.
  - Bioventing – supply of air and nutrients through wells to contaminated soil to stimulate the growth of indigenous bacteria. It is used for simple hydrocarbons and can be used where the contamination is deep under the surface.
  - Biosparging - Injection of air under pressure below the water table to increase groundwater oxygen concentrations and enhance the rate of biological degradation of contaminants by naturally occurring bacteria
  - Bioaugmentation - Microorganisms are imported to a contaminated site to enhance degradation process.

Do you know?

The jaws of the snakes are not fused together. That means that unlike our jaws, snakes jaws are not hooked up at the back of their mouths. This makes it possible for them to eat very big meals, bigger than their own heads!

(b) Ex situ bioremediation techniques

- Ex situ -involves the removal of the contaminated material to be treated elsewhere.
  - Landfarming - contaminated soil is excavated and spread over a prepared bed and periodically tilled [] until pollutants are degraded.The goal is to

stimulate indigenous biodegradative microorganisms and facilitate their aerobic degradation of contaminants.

- Biopiles - it is a hybrid of landfarming and composting. Essentially, engineered cells are constructed as aerated composted piles. Typically used for treatment of surface contamination with petroleum hydrocarbons.
- Bioreactors – it involves the processing of contaminated solid material (soil, sediment, sludge) or water through an engineered containment system.
- Composting – dealt earlier in solid waste management

> Using bioremediation techniques, TERI has developed a mixture of bacteria called 'oilzapper' which degrades the pollutants of oil-contaminated sites, leaving behind no harmful residues. This technique is not only environment friendly, but also highly cost-effective.

5.8.2. Genetic engineering approaches

Phytoremediation

- Phytoremediation is use of plants to remove contaminants from soil and water .

Types

- Phytoextraction / phytoaccumulation is the process by which plants accumulate contaminants into the roots and aboveground shoots or leaves.
- Phytotransformation or phytodegradation refers to the uptake of organic contaminants from soil, sediments, or water and their transformation to more stable, less toxic, less mobile form.
- Phytostabilization is a technique in which plants reduce the mobility and migration of contaminated soil. Leachable constituents are adsorbed and bound into the plant structure so that they form unstable mass of plant from which the contaminants will not re-enter the environment.
- Phytodegradation or rhizodegradation is the breakdown of contaminants through the activity existing in the rhizosphere. This activity is due to the presence of proteins and enzymes produced by the plants or by soil organisms such as bacteria, yeast, and fungi.
- Rhizofiltration is a water remediation technique that involves the uptake of contaminants by plant roots. Rhizofiltration is used to reduce contamination in natural wetlands and estuary areas.

> The bacterium Deinococcus radiodurans has been used to de toxify toluene and ionic mercury which are released from radioactive nuclear waste.

Mycoremediation

- is a form of bioremediation in which fungi are used to decontaminate the area.

Mycofiltration

- is a similar process, using fungal mycelia to filter toxic waste and microorganisms from water in soil.

Advantages of bioremediation

- Useful for the complete destruction of a wide variety of contaminants.
- The complete destruction of target pollutants is possible.
- Less expensive.
- Environment friendly

Disadvantages of bioremediation

- Bioremediation is limited to those compounds that are biodegradable. Not all compounds are susceptible to rapid and complete degradation.
- Biological processes are often highly specific.
- It is difficult to extrapolate from bench and pilot-scale studies to full-scale field operations.
- Bioremediation often takes longer time than other treatment process.

> **Do you know?**
>
> Rattlesnakes are easily recognized by their rattle. The rattlesnake babies are born with what is called a pre-button. The baby snake loses this piece when it sheds its skin for the first time. With the shedding a new button appears. With every shedding after that another button, or rattle, will be added. These buttons are made up of a material called Keratin. The rattles are empty. The noise comes from each segment knocking together, so until a rattlesnake has two or more pieces it isn't going to make a sound! But when it does...you WILL hear it...and you WILL RUN!

◆◆◆◆◆◆

CHAPTER - 6

ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Protection and Sustainable Development has been the cornerstones of the policies and procedures governing the industrial and other developmental activities in India. Ministry of Environment & Forests has taken several policy initiatives and enacted environmental and pollution control legislations to prevent indiscriminate exploitation of natural resources and to promote integration of environmental concerns in developmental projects.

One such initiative is the Notification on Environmental Impact Assessment (EIA) of developmental projects 1994 under the provisions of Environment (Protection) Act, 1986 making EIA mandatory for 29 categories of developmental projects. One more item was added to the list in January, 2000.

Environment Impact Assessment Notification of 2006 has categorized the developmental projects in two categories, i.e., Category A and Category B.

'Category A' projects are appraised at national level by expert appraisal committee.

India has constituted the State Level Environment Impact Assessment Authority (SEIAA) and State Level Expert Appraisal Committee (SEAC) to decentralize the environmental clearance process.

These institutions are responsible for appraising certain categories of projects, termed as 'Category B' projects, which are below a prescribed threshold level.

EIA is a planning tool that is now generally accepted as an integral component of sound decision-making. The objective of EIA is to foresee and address potential environmental problems/concerns at an early stage of project planning and design. EIA/ Environment Management Plan (EMP) should assist planners and government authorities in the decision making process by identifying the key impacts/issues and formulating the mitigation measures.

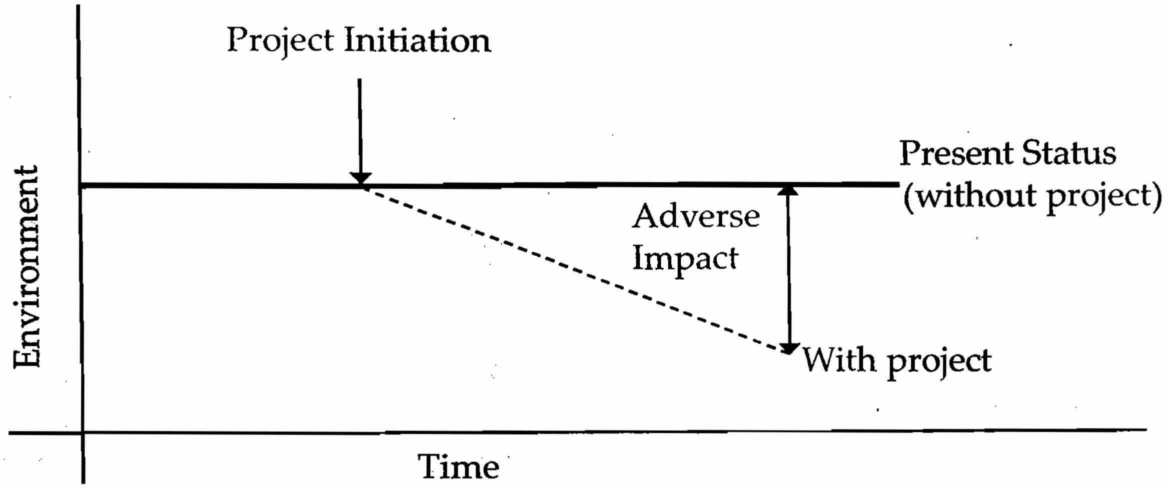
THE NEED FOR EIA

- Every anthropogenic activity has some impact on the environment. More often it is harmful to the environment than benign. However, mankind as it is developed today cannot live without taking up these activities for his food, security and other needs. Consequently, there is a need to harmonise developmental activities with the environmental concerns. Environmental impact assessment (EIA) is one of the tools available with the planners to achieve the above-mentioned goal.
- It is desirable to ensure that the development options under consideration are sustainable. In doing so, environmental consequences must be characterised early in the project cycle and accounted for in the project design.
- The objective of EIA is to foresee the potential environmental problems that would arise out of a proposed development and address them in the project's planning and design stage. The EIA process should then allow for the communication of this information to:
  - the project proponent;
  - the regulatory agencies; and,
  - all stakeholders and interest groups.

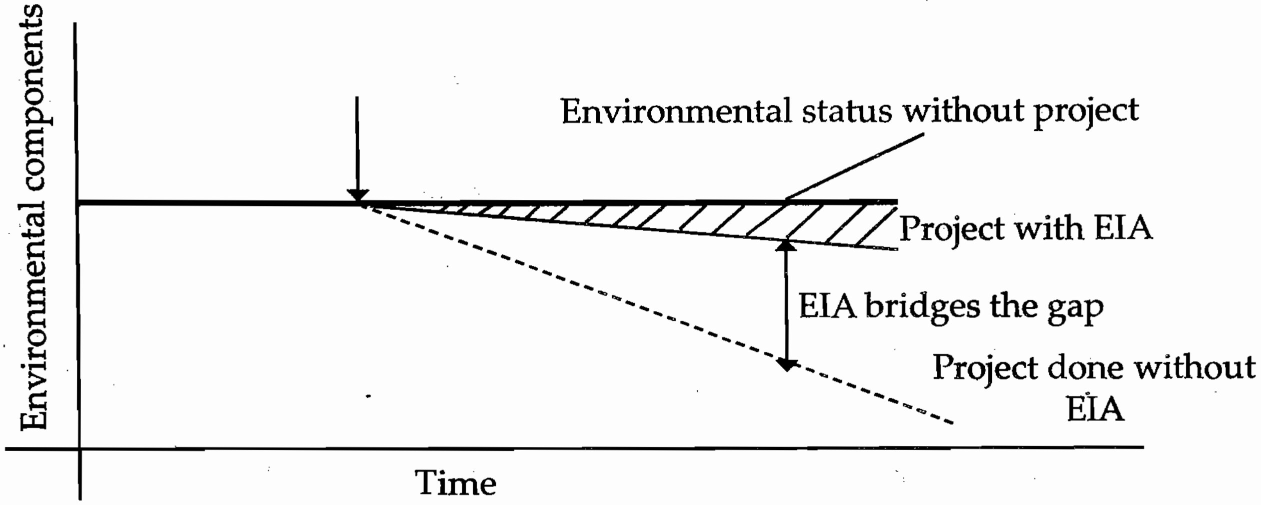
EIA integrates the environmental concerns in the developmental activities right at the time of initiating for preparing the feasibility report. In doing so it can enable the integration of environmental concerns and mitigation measures in project development. EIA can often prevent future liabilities or expensive alterations in project design.

Do you know?

India has the worst air pollution in the entire world, according to a study released by World Economic Forum. Of 132 countries, India ranks dead last in the 'Air (effects on human health)' ranking.



(a) Anticipated environment impact of development project.



(b) Environent impact rectification after EIA

6.1. INDIAN POLICIES REQUIRING EIA

- The environmental impact assessment in India was started in 1976-77 when the Planning Commission asked the then Department of Science and Technology to examine the river-valley projects from environmental angle. This was subsequently extended to cover those projects, which required approval of the Public Investment Board. These were administrative decisions, and lacked the legislative support. The Government of India enacted the Environment (Protection) Act on 1986. To achieve the objectives of the Act, one of the decisions that were taken is to make environmental impact assessment statutory. After following the legal procedure, a notification was issued on 1994 and subsequently amended on 1994, 1997 and 2000 (Annex 1) making environmental impact assessment statutory for 30 activities.

Besides this the Government of India under Environment (Protection) Act 1986 issued a number of other notifications, which are related to environmental impact assessment. These are limited to specific geographical areas. They are

- Prohibiting location of industries except those related to Tourism in a belt of 1 km from high tide mark from the Revdanda Creek up to Devgarh Point (near Shrivardhan) as well as in 1 km belt along the banks of Rajpuri Creek in Murud Janjira area in the Raigarh district of Maharashtra (1989)
- Restricting location of industries, mining operations and regulating other activities in Doon Valley (1989)
- Regulating activities in the coastal stretches of the country by classifying them as coastal regulation zone and prohibiting certain activities (1991)
- Restricting location of industries and regulating other activities in Dahanu Taluka in Maharashtra (1991)
- Restricting certain activities in specified areas of Aravalli Range in the Gurgaon district of Haryana and Alwar district of Rajasthan (1992)
- Regulating industrial and other activities, which could lead to pollution and congestion in an area north west of Numaligarh in Assam (1996)

SALIENT FEATURES OF EIA NOTIFICATION, 1994

- Any person who desires to undertake any new project in any part of India or the expansion or modernization of any existing industry or project listed in the Schedule-I shall submit an application to the Secretary, Ministry of Environment and Forests, New Delhi.
- Cases rejected due to submission of insufficient or inadequate data and Plans may be reviewed as and when submitted with complete data and Plans. Submission of incomplete data or plans for the second time would itself be a sufficient reason for the Impact assessment Agency to reject the case summarily.
- In case of the following site specific projects:
  a. mining;
  b. pit-head thermal power stations;
  c. hydro-power, major irrigation projects and/or their combination including flood control;
  d. ports and harbours (excluding minor ports);
  e. prospecting and exploration of major minerals in areas above 500 hectares;
- The project authorities will intimate the location of the project site to the Central Government (MoEF) while initiating any investigation and surveys. The Central Government (MoEF) will convey a decision regarding suitability or otherwise of the proposed site within a maximum period of thirty days. The said site clearance shall be granted for a sanctioned capacity and shall be valid for a period of five years for commencing the construction, operation or mining.
- The reports submitted with the application shall be evaluated and assessed by the Impact Assessment Agency, and if deemed necessary it may consult a committee of Experts. The Impact Assessment Agency (IAA) would be the Union Ministry of Environment and Forests. The Committee of Experts mentioned above shall be constituted by the Impact Assessment Agency or such other body under the Central Government authorised by the Impact Assessment Agency in this regard.
- The said Committee of Experts shall have full right of entry and inspection of the site or, as the case may be, factory premises at any time prior to, during or after the commencement of the operations relating to the project.
- The Impact Assessment Agency shall prepare a set of recommendations based on technical assessment of documents and data, furnished by the project authorities, supplemented by data collected during visits to sites or factories if undertaken, and details of public hearing.
- The assessment shall be completed within a period of ninety days from receipt of the requisite documents and data from the project authorities and completion of public hearing and decision conveyed within thirty days thereafter.
- The clearance granted shall be valid for a period of five years for commencement of the construction or operation of the project.
- A No construction work, preliminary or otherwise, relating to the setting up of the project

may be undertaken till the environmental and site clearance is obtained.

- In order to enable the Impact Assessment Agency to monitor effectively the implementation of the recommendations and conditions subject to which the environmental clearance has been given, the project authorities concerned shall submit a half yearly report to the Impact Assessment Agency. Subject to the public interest, the Impact Assessment Agency shall make compliance reports publicly available.
- If no comments from the Impact Assessment Agency are received within the time limit, the project would be deemed to have been approved as proposed by project authorities.

> Nothing contained in this Notification shall apply to:
>
> a. any item falling under entry Nos. 3, 18 and 20 of the Schedule-I to be located or proposed to be located in the areas covered by the MoEF Notifications.
>
> b. any item falling under entry Nos.1, 2, 3, 4, 5, 9, 10, 13, 16, 17, 19, 21, 25 and 27 of Schedule-I if the investment is less than Rs.50 crores.
>
> c. any item reserved for Small Scale Industrial Sector with investment less than Rs. 1 crore.
>
> d. defence related road construction projects in border areas.

- Concealing factual data or submission of false, misleading data/reports, decisions or recommendations would lead to the project being rejected. Approval, if granted earlier on the basis of false data, would also be revoked. Misleading and wrong information will cover the following:

a. False information

b. False data

c. Engineered reports

d. Concealing of factual data

e. False recommendations or decisions

SCHEDULE-I

LIST OF PROJECTS REQUIRING ENVIRONMENTAL CLEARANCE FROM THE CENTRAL GOVERNMENT

1. Nuclear Power and related projects such as Heavy Water Plants, nuclear fuel complex, Rare Earths.
2. River Valley projects including hydel power, major Irrigation and their combination including flood control.
3. Ports, Harbours, Airports (except minor ports and harbours).
4. Petroleum Refineries including crude and product pipelines.
5. Chemical Fertilizers (Nitrogenous and Phosphatic other than single superphosphate).
6. Pesticides (Technical).
7. Petrochemical complexes (Both Olefinic and Aromatic) and Petro-chemical intermediates such as DMT, Caprolactam, LAB etc. and production of basic plastics such as LLDPE, HDPE, PP, PVC.
8. Bulk drugs and pharmaceuticals.
9. Exploration for oil and gas and their production, transportation and storage.
10. Synthetic Rubber.
11. Asbestos and Asbestos products.
12. Hydrocyanic acid and its derivatives.
13. (a) Primary metallurgical industries (such as production of Iron and Steel, Aluminium, Copper, Zinc, Lead and Ferro Alloys).
    (b) Electric arc furnaces (Mini Steel Plants).
14. Chlor alkali industry.
15. Integrated paint complex including manufacture of resins and basic raw materials required in the manufacture of paints.
16. Viscose Staple fibre and filament yarn.
17. Storage batteries integrated with manufacture of oxides of lead and lead antimony alloys.
18. All tourism projects between 200m 500 metres of High Water Line and at locations with an elevation of more than 1000 metres with investment of more than Rs.5 crores.
19. Thermal Power Plants.
20. Mining projects *(major minerals)* with leases more than 5 hectares.

21. Highway Projects **except projects relating to improvement work including widening and strengthening of roads with marginal land acquisition along the existing alignments provided it does not pass through ecologically sensitive areas such as National Parks, Sanctuaries, Tiger Reserves, Reserve Forests**
22. Tarred Roads in the Himalayas and or Forest areas.
23. Distilleries.
24. Raw Skins and Hides
25. Pulp, paper and newsprint.
26. Dyes.
27. Cement.
28. Foundries (individual)
29. Electroplating
30. Meta amino phenol

6.2 THE EIA CYCLE AND PROCEDURES

The EIA process in India is made up of the following phases:

- Screening
- Scoping and consideration of alternatives
- Baseline data collection
- Impact prediction
- Assessment of alternatives, delineation of mitigation measures and environmental impact statement
- Public hearing
- Environment Management Plan
- Decision making
- Monitoring the clearance conditions

6.2.1 Screening

- Screening is done to see whether a project requires environmental clearance as per the statutory notifications. Screening Criteria are based upon:
    - Scales of investment;
    - Type of development; and,
    - Location of development.
- A Project requires statutory environmental clearance only if the provisions of EIA notification and/or one or more statutory notification mentioned in Box 1 cover it

6.2.2 Scoping

- Scoping is a process of detailing the terms of reference of EIA. It has to be done by the consultant in consultation with the project proponent and guidance, if need be, from Impact Assessment Agency.
- The Ministry of Environment and Forests has published guidelines for different sectors, which outline the significant issues to be addressed in the EIA studies. Quantifiable impacts are to be assessed on the basis of magnitude, prevalence, frequency and duration and non-quantifiable impacts (such as aesthetic or recreational value), significance is commonly determined through the socio-economic criteria. After the areas, where the project could have significant impact, are identified, the baseline status of these should be monitored and then the likely changes in these on account of the construction and operation of the proposed project should be predicted.

6.2.3 Baseline Data

- Baseline data describes the existing environmental status of the identified study area. The site-specific primary data should be monitored for the identified parameters and supplemented by secondary data if available.

6.2.4 Impact Prediction

- Impact prediction is a way of mapping the environmental consequences of the significant aspects of the project and its alternatives. Environmental impact can never be predicted with absolute certainty and this is all the more reason to consider all possible factors and take all possible precautions for reducing the degree of uncertainty.

The following impacts of the project should be assessed:

Air

- changes in ambient levels and ground level concentrations due to total emissions from point, line and area sources
- effects on soils, materials, vegetation, and human health

Noise

- changes in ambient levels due to noise generated from equipment and movement of vehicles
- effect on fauna and human health

Water

- availability to competing users
- changes in quality
- sediment transport
- ingress of saline water

Land

- changes in land use and drainage pattern
- changes in land quality including effects of waste disposal
- changes in shoreline/riverbank and their stability

Biological

- deforestation/tree-cutting and shrinkage of animal habitat.
- impact on fauna and flora (including aquatic species if any) due to contaminants/pollutants
- impact on rare and endangered species, endemic species, and migratory path/route of animals.

Impact on breeding and nesting grounds

Socio-Economic

- impact on the local community including demographic changes.

Impact on economic status

- impact on human health.
- impact of increased traffic

6.2.5 Assessment of Alternatives, Delineation of Mitigation Measures and Environmental Impact Assessment Report

- For every project, possible alternatives should be identified and environmental attributes compared. Alternatives should cover both project location and process technologies. Alternatives should consider no project option also. Alternatives should then be ranked for selection of the best environmental option for optimum economic benefits to the community at large.
- Once alternatives have been reviewed, a mitigation plan should be drawn up for the selected option and is supplemented with an Environmental Management Plan (EMP) to guide the proponent towards environmental improvements. The EMP is a crucial input to monitoring the clearance conditions and therefore details of monitor should be included in the EMP.
- An EIA report should provide clear information to the decision-maker on the different environmental scenarios without the project, with the project and with project alternatives. Uncertainties should be clearly reflected in the EIA report.

6.2.6 Public Hearing

- Law requires that the public must be informed and consulted on a proposed development after the completion of EIA report.
- Any one likely to be affected by the proposed project is entitled to have access to the Executive Summary of the EIA. The affected persons may include:
  - bonafide local residents;
  - local associations;
  - environmental groups: active in the area
  - any other person located at the project site / sites of displacement
  - They are to be given an opportunity to make oral/written suggestions to the State Pollution Control Board.

6.2.7. Environment Management Plan

Environment Management Plan should include:

- Delineation of mitigation and compensation measures for all the identified significant impacts
- Delineation of unmitigated impacts
- Physical planning including work programme, time schedule and locations for putting mitigation and compensation systems in place
- Delineation of financial plan for implementing the mitigation measures in the form of budgetary estimates and demonstration of its inclusion in the project budget estimates.

6.2.8 Decision Making

- Decision making process involve consultation between the project proponent (assisted by a consultant) and the impact assessment authority (assisted by an expert group if necessary)
- The decision on environmental clearance is arrived through a number of steps including evaluation of EIA and EMP.

6.2.9 Monitoring the Clearance Conditions

- Monitoring should be done during both construction and operation phases of a project. This is not only to ensure that the commitments made are complied with but also to observe whether the predictions made in the EIA reports were correct or not. Where the impacts exceed the predicted levels, corrective action should be taken. Monitoring will enable the regulatory agency to review the validity of predictions and the conditions of implementation of the Environmental Management Plan (EMP).

6.3 COMPONENTS OF EIA

- The difference between Comprehensive EIA and Rapid EIA is in the time-scale of the data supplied. Rapid EIA is for speedier appraisal process. While both types of EIA require inclusion/ coverage of all significant environmental impacts and their mitigation, Rapid EIA achieves this through the collection of one season (other than monsoon) data only to reduce the time required. This is acceptable if it does not compromise on the quality of decision-making. The review of Rapid EIA submissions will show whether a comprehensive EIA is warranted or not.
- It is, therefore, clear that the submission of a professionally prepared Comprehensive EIA in the first instance would generally be the more efficient approach. Depending on nature, location and scale of the project EIA report should contain all or some of the following components.

Air Environment

- Determination of impact zone (through a screening model) and developing a monitoring network
- Monitoring the existing status of ambient air quality within the impacted region (7-10 km from the periphery) of the proposed project site
- Monitoring the site-specific meteorological data, viz. wind speed and direction, humidity, ambient temperature and environmental lapse rate
- Estimation of quantities of air emissions including fugitive emissions from the proposed project
- Identification, quantification and evaluation of other potential emissions (including those of vehicular traffic) within the impact zone and estimation of cumulative of all the emissions/ impacts
- Prediction of changes in the ambient air quality due to point, line and areas source emissions through appropriate air quality models
- Evaluation of the adequacy of the proposed pollution control devices to meet gaseous emission and ambient air quality standards
- Delineation of mitigation measures at source, path ways and receptor

Noise Environment

- Monitoring the present status of noise levels within the impact zone, and prediction of future noise levels resulting from the proposed project and related activities including increase in vehicular movement
- Identification of impacts due to any anticipated rise in noise levels on the surrounding environment
- Recommendations on mitigation measures for noise pollution

Water Environment

- Study of existing ground and surface water resources with respect to quantity and quality within the impact zone of the proposed project
- Prediction of impacts on water resources due to the proposed water use/pumping on account of the project
- Quantification and characterisation of waste water including toxic organic, from the proposed activity
- Evaluation of the proposed pollution prevention and wastewater treatment system and suggestions on modification, if required
- Prediction of impacts of effluent discharge on the quality of the receiving water body using appropriate mathematical/simulation models
- Assessment of the feasibility of water recycling and reuse and delineation of detailed plan in this regard

Biological Environment

Survey of flora and fauna clearly delineating season and duration.

- Assessment of flora and fauna present within the impact zone of the project
- Assessment of potential damage to terrestrial and aquatic flora and fauna due to discharge of effluents and gaseous emissions from the project
- Assessment of damage to terrestrial flora and fauna due to air pollution, and land use and landscape changes
- Assessment of damage to aquatic and marine flora and fauna (including commercial fishing) due to physical disturbances and alterations
- Prediction of biological stresses within the impact zone of the proposed project
- Delineation of mitigation measures to prevent and / or reduce the damage.

Land Environment

- Studies on soil characteristics, existing land use and topography, landscape and drainage patterns within the impact zone
- Estimation on impacts of project on land use, landscape, topography, drainage and hydrology
- Identification on potential utility of treated effluent in land application and subsequent impacts
- Estimation and Characterisation of solid wastes and delineation of management options for minimisation of waste and environmentally compatible disposal

Socio-economic and Health Environment

- Collection of demographic and related socio-economic data
- Collection of epidemiological data, including studies on prominent endemic diseases (e.g. fluorosis, malaria, fileria, malnutrition) and morbidity rates among the population within the impact zone
- Projection of anticipated changes in the socio-economic and health due to the project and related activities including traffic congestion and delineation of measures to minimise adverse impacts
- Assessment of impact on significant historical, cultural and archaeological sites/places in the area
- Assessment of economic benefits arising out of the project
- Assessment of rehabilitation requirements with special emphasis on scheduled areas, if any.

Risk Assessment

- Hazard identification taking recourse to hazard indices, inventory analysis, dam break probability, Natural Hazard Probability etc.
- Maximum Credible Accident (MCA) analysis to identify potential hazardous scenarios
- Consequence analysis of failures and accidents resulting in fire, explosion, hazardous releases and dam breaks etc.
- Hazard & Operability (HAZOP) studies
- Assessment of risk on the basis of the above evaluations
- Preparation of an onsite and off site (project affected area) Disaster Management Plan

Environment Management Plan

- Delineation of mitigation measures including prevention and control for each environmental component and rehabilitation and resettlement plan.
- Delineation of monitoring scheme for compliance of conditions
- Delineation of implementation plan including scheduling and resource allocation

6.4. KEY ELEMENTS OF AN INITIAL PROJECT DESCRIPTION AND SCOPING

- The key environmental issues to be considered in relation to a project characteristics are discussed in Sectoral Guidelines published by MoEF from time to time.
- An Initial Project Description (IPD) should at the very least, provide the reviewer with all the information necessary to enable project screening and scoping.

Specific information that must be covered by the IPD includes:

- Location/current land use along with contours and whether it conforms to the development plans proposed for that area
- Details of proposed project activity including the project cost
- Outlining the key project elements during the pre-construction, the construction and the operation phases etc. as per the

list of documents to be attached with the questionnaire

- The IPD may also include.
- Off-site activities
- Associated activities
- Expected project induced activities
- Project activities as PERT chart and process as a flow chart delineating unit processes with input-output.

➢ This would facilitate the reviewers task. The project proponent after suitable scoping should provide environmental information for consideration in detailed EIA. The reviewer while assessing the report should focus on the crucial aspects involving project location and characteristics.

6.4.1 Project Location(s)

➢ The site(s) selection can be an effective approach in minimising the requirement of mitigation measures.

➢ Proposed project locations should be reviewed based upon regulatory and non-regulatory criteria.

➢ Project siting restrictions depend on the sensitivity of the surrounding environment. Sensitivity should be assessed in relation to proximity of the project to the places/sites listed in the identified ecologically sensitive zones (ESZ) notified by MOEF.

The siting criteria delineated by MoEF include:

I. As far as possible prime agricultural land/forest land may not be converted into an industrial site

II. Land acquired should be minimum but sufficient to provide for a green belt wherein the treated wastewater, if possible/suitable, could be utilised from wastewater treatment systems

III. Enough space may be provided for storing solid wastes. The space and the waste can be made available for possible reuse in future

IV. Layout and form of the project must conform to the landscape of the area without unduly affecting the scenic features of that place

V. Associated township of the project if any to be created must provide for space for phyto- graphic barrier between the project and the township and should take into account predominant wind direction.

In addition the following distances should be maintained:

➢ **Coastal Areas:** at least 1/2 km from the high tide line (within 0.5 km of High Tide Line (HTL), specified activities as per CRZ notification, 1991 are permitted)(The HTL is to be delineated by the authorised agency only.)

➢ **Estuaries:** At least 200 metres from the estuary boundaries

➢ **Flood Plains of the Riverine systems:** at least 500 metres from flood plain or modified flood plain or by flood control systems

➢ **Transport/Communication System:** at least 500 metres from highway and railway

➢ Major Settlements (3,00,000 population) at least 25 km from the projected growth boundary of the settlement

In addition to the siting criteria listed above, the proposed project location should be reviewed in relation to the following salient issues:

➢ Ambient air, water and noise quality standards

➢ Critically polluted areas

➢ Natural disaster prone areas

➢ Ecologically sensitive areas

➢ Availability of water and other critical infrastructures like electricity, roads with adequate width and capacity

PROCEDURE FOR PUBLIC HEARING

(1) Process of Public Hearing: -

Whoever apply for environmental clearance of projects, shall submit to the concerned State Pollution Control Board twenty sets of the following documents namely: -

i. An executive summary containing the salient features of the project both in English as well as local language.

ii. Form XIII prescribed under Water (Prevention and Control of Pollution) Rules, 1975 where discharge of sewage, trade effluents, treatment of water in any form, is required.

iii. Form I prescribed under Air (Prevention and Control of Pollution) Under Territory Rules, 1983 where discharge of emissions are involved in any process, operation or industry.

iv. Any other information or document, which is necessary in the opinion of the Board for their final disposal of the application.

(2) Notice of Public Hearing: -

i. The State Pollution Control Board shall cause a notice for environmental public hearing which shall be published in at least two newspapers widely circulated in the region around the project, one of which shall be in the vernacular language of the locality concerned. State Pollution Control Board shall mention the date, time and place of public hearing. Suggestions, views, comments and objections of the public shall be invited within thirty days from the date of publication of the notification.

ii. All persons including bona fide residents, environmental groups and others located at the project site/sites of displacement/sites likely to be affected can participate in the public hearing. They can also make oral/ written suggestions to the State Pollution Control Board.

Explanation: -

- For the purpose of the paragraph person means:
  a. any person who is likely to be affected by the grant of environmental clearance;
  b. any person who owns or has control over the project with respect to which an application has been submitted for environmental clearance;
  c. any association of persons whether incorporated or not, like to be affected by the project and/or functioning in the field of environment;
  d. any local authority within any part of whose local limits is within the neighbourhood, wherein the project is proposed to be located.

(3) Composition of public hearing panel: -

The composition of Public Hearing Panel may consist of the following, namely: -

i. Representative of State Pollution Control Board;

ii. District Collector or his nominee;

iii. Representative of State Government dealing with the subject;

iv. Representative of Department of the State Government dealing with Environment;

v. Not more than three representatives of the local bodies such as Municipalities or panchayats;

vi. Not more than three senior citizens of the area nominated by the District Collector.

List of Environmentally Sensitive Places

- Religious and historic places
- Archaeological monuments/sites
- Scenic areas
- Hill resorts/mountains/ hills
- Beach resorts
- Health resorts
- Coastal areas rich in corals, mangroves, breeding grounds of specific species
- Estuaries rich in mangroves, breeding ground of specific species
- Gulf areas
- Biosphere reserves
- National park and wildlife sanctuaries
- Natural lakes, swamps Seismic zones tribal Settlements
- Areas of scientific and geological interests
- Defense installations, specially those of security importance and sensitive to pollution
- Border areas (international)
- Airport
- Tiger reserves/elephant reserve/turtle nestling grounds
- Habitat for migratory birds
- Lakes, reservoirs, dams
- Streams/rivers/estuary/seas
- Railway lines
- Highways
- Urban agglomeration

◆◆◆◆◆◆

PART - II

CHAPTER - 7

BIODIVERSITY

From the hot arid deserts of the Thar, through the lush green rainforests of the Western Ghats and north east, to the ocean depths and bright corals of Gulf of Mannar and Andaman & Nicobar, our country is a marvel of different landscapes, materials, colours and textures. The land, air and seas of our planet are home to the tiniest insects and the largest animals, which make up a rich tapestry of interconnecting and interdependent forces.

This is life, This is Biodiversity.

Biodiversity found on Earth today consists of many millions of distinct biological species, the product of four billion years of evolution. Biodiversity is the variety of life on Earth, it includes all organisms, species, and populations; the genetic variation among these; and their complex assemblages of communities and ecosystems. It also refers to the interrelatedness of genes, species, and ecosystems and in turn, their interactions with the environment.

7.1. BIODIVERSITY

The word "Biodiversity" is thought to have first been coined as a contraction of the term "biological diversity" in 1985 and then popularized by a number of authors.

Biodiversity is defined as 'the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems'.

- United Nations Earth Summit (1992)

Do you know?

Sea snakes are very poisonous. The most poisonous one is the Beaded Sea Snake. Just 3 drops of venom can kill about 8 people! Their other methods of defense include to spray a stinky, musky liquid or to poop. Eew!

Therefore, in other words, Biodiversity or Biological diversity includes all the different plants, animals and microorganisms, the genes they contain and the ecosystems of which they form a part.

India is a recognised as one of the mega-diverse countries, rich in biodiversity and associated traditional knowledge. With just 2.4% of the land area, India accounts for nearly 7% of the recorded species even while supporting almost 18% of human population.

India has a long history of conservation and sustainable use of natural resources and is a party to many international environmental conventions.

Conservation and sustainable use of biodiversity is fundamental to ecologically sustainable development. Biodiversity is part of our daily lives and livelihood, and constitutes resources upon which families, communities, nations and future generations depend.

7.1.1. Levels of Biodiversity

Biodiversity is considered to exist at three levels: genetics, species, and ecosystems.

(a) Genetic diversity:

- It is concerned with the variation in genes within a particular species.
- It is the total number of genetic characteristics in the genetic makeup of a species.
- Genetic diversity allows species to adapt to changing environments.
- This diversity aims to ensure that some species survive drastic changes and thus carry on desirable genes.
- The survival of individuals ensures the survival of the population.
- The genetic diversity gives us beautiful butterflies, roses, parakeets or coral in a myriad hues, shapes and sizes.

(b) Species diversity:

- It refers to the variety of living organisms on earth.
- Species differ from one another, markedly in their genetic makeup, do not inter-breed in nature.
- Closely-related species however have in common much of their hereditary characteristics. For instance, about 98.4 per cent of the genes of humans and chimpanzees are the same.
- It is the ratio of one species population over total number of organisms across all species in the given biome.
- 'Zero' would be infinite diversity, and 'one' represents only one species present.

(c) Ecosystem/ Community diversity:

- This refers to the different types of habitats. A habitat is the cumulative factor of the climate, vegetation and geography of a region.
- There are several kinds of habitats around the world. Corals, grasslands, wetland, desert, mangrove and tropical rain forests are examples of ecosystems.
- Change in climatic conditions is accompanied by a change in vegetation as well. Each species adapts itself to a particular kind of environment.
- As the environment changes, species best adapted to that environment becomes predominant. Thus the variety or diversity of species in the ecosystem is influenced by the nature of the ecosystem.

Do you know?

The most dangerous sharks are the Great White shark, the Tiger shark, the Hammerhead shark, the Mako shark and the Bull shark. On average, there are only about 100 shark attacks each year and only 10 of those result in a human death. People kill thousands of sharks in a year for sport and for food. Shark skins are used to make leather products. Until the 1950 s, shark livers were used as a vitamin A supplement. Shark fin soup and shark steaks are both eaten in many countries. So... who's the dangerous predator?

7.1.2. Measurement of Biodiversity

Diversity is a single statistic in which the number of species richness and evenness are compounded.

Biodiversity is measured by two major components:

i. species richness, and

ii. species evenness.

(i) Species richness

It is the measure of number of species found in a community

a) Alpha diversity

It refers to the diversity within a particular area or ecosystem, and is usually expressed by the number of species (i.e., species richness) in that ecosystem.

b) Beta diversity

It is a comparison of diversity between ecosystems, usually measured as the change in amount of species between the ecosystems

c) Gamma diversity

It is a measure of the overall diversity for the different ecosystems within a region.

(ii) Species evenness

It measures the proportion of species at a given site, e.g. low evenness indicates that a few species dominate the site.

7.1.3. Biodiversity and Food Web

Biodiversity is important to maintain the 'web of life'. The building blocks of plants, animals and humans are identical, and are made of the four elements - carbon, oxygen, nitrogen and hydrogen.

These elements are present in the environment - in air, water and soil. However, only green plants can absorb nitrogen from the soil through their roots, and use sunlight and water to produce energy by a process called photosynthesis. They are known as producers.

Animals and humans, who have plants or other animals as their food, are known as consumers. The chain that links consumers to producers is called the food chain or web of life.

Every living creature is found in a food chain. There are several food chains and they can be complex or simple depending on the environment.

To cite some examples, grasshoppers eat grass and are in turn eaten by frogs; snakes eat frogs and rodents.

Thus the importance of each and every creature in the web of life is evident. Tampering with the food chain only produces negative results, leading to the destruction of the species.

This shows why biodiversity and all its components are essential to maintain ecological balance. Man is only a strand in the delicate web of relationship in the global ecosystem Every time a species becomes extinct, the strand is broken and many species, including humans, move closer to extinction.

7.1.4. Services provided by Biodiversity:

Biodiversity provides a number of natural services for human beings:

(a) Ecosystem services

- Protection of water resources
- Soils formation and protection
- Nutrient storage and recycling
- Pollution breakdown and absorption
- Contribution to climate stability
- Maintenance of ecosystems
- Recovery from unpredictable events

(b) Biological services

- Food
- Medicinal resources and pharmaceutical drugs
- Wood products
- Ornamental plants
- Breeding stocks, population reservoirs
- Future resources
- Diversity in genes, species and ecosystems

(c) Social services

- Research, education and monitoring
- Recreation and tourism
- Cultural values

7.1.5. Causes for Biodiversity Loss

Loss of biodiversity occurs when either a particular species is destroyed or the habitat essential for its survival is damaged. The latter is more common as habitat destruction is inevitable fallout of development.

The extinction of species takes place when they are exploited for economic gain or hunted as sport or for food. Extinction of species may also occur due to environmental reasons like ecological substitutions, biological factors and pathological causes which can be caused either by nature or man.

(a) Natural causes

- floods,
- earthquakes,
- landslides,
- rivalry among species,
- lack of pollination and diseases.

(b) Man-Made causes

- Habitat destruction
- Uncontrolled commercial exploitation
- Hunting & poaching
- Conversion of rich bio-diversity site for human settlement and industrial development
- Extension of agriculture
- Pollution
- Filling up of wetlands
- Destruction of coastal areas

7.1.6. Biodiversity conservation

Conservation of biological diversity leads to conservation of essential ecological diversity to preserve the continuity of food chains.

- ➢ The genetic diversity of plants and animals is preserved.
- ➢ It ensures the sustainable utilization of life support systems on earth.
- ➢ It provides a vast knowledge of potential use to the community.
- ➢ A reservoir of wild animals and plants is preserved, thus enabling them to be introduced, if need be, in the surrounding areas.
- ➢ Biodiversity conservation assures sustainable utilization of potential resources.

Do you know?

Not all snakes have fangs. Only the poisonous ones do. Fangs are sharp, long, hollow teeth that are hooked up to small sacs in the snake's head behind their eyes. These sacs produce a poisonous liquid called venom. When a snake bites, venom is released and starts to work immediately to kill or paralyze the prey.

7.1.7. Modes of Conservation

(a) **Ex-situ conservation:** Conserving biodiversity outside the areas where they naturally occur is known as exsitu conservation.

- Here, animals are reared or plants are cultivated like zoological parks or botanical gardens. Reintroduction of an animal or plant into the habitat from where it has become extinct is another form of ex situ conservation.
- For example, the Gangetic gharial has been reintroduced in the rivers of Uttar Pradesh, Madhya Pradesh and Rajasthan where it had become extinct.
- Seed banks, botanical, horticultural and recreational gardens are important centres for ex-situ conservation.

(b) **In-situ conservation:** Conserving the animals and plants in their natural habitats is known as in-situ conservation. The established natural habitats are:

- National parks
- Sanctuaries
- Biosphere reserves and
- Reserved forests
- Protected forests
- Nature reserves

Constraints in biodiversity conservation

- ➢ Low priority for conservation of living natural resources.
- ➢ Exploitation of living natural resources for monetary gain.
- ➢ Values and knowledge about the species and ecosystem inadequately known.
- ➢ Unplanned urbanization and uncontrolled industrialization.

7.1.8. Botanical garden

Botanical garden refers to the scientifically planned collection of living trees, shrubs, herbs, climbers and other plants from various parts of the globe.

Purpose of botanical gardens

1. To study the taxonomy as well as growth of plants.
2. To study the introduction and acclimatization process of exotic plants.
3. It acts as a germplasm collection.
4. It helps development of new hybrids.
5. It augments conserving rare and threatened species.
6. It facilitates training of staff.
7. It acts as a source of recreation.

7.1.9. ZOO

Zoo is an establishment, whether stationary or mobile, where captive animals are kept for exhibition to the public and includes a circus and rescue centers but does not include an establishment of a licensed dealer in captive animals - CZA.

The initial purpose of zoos was entertainment, over the decades, zoos have got transformed into centres for wildlife conservation and environmental education.

Apart from saving individual animals, zoos have a role to play in species conservation too (through captive breeding).

Zoos provide an opportunity to open up a whole new world, and this could be used in sensitising visitors regarding the value and need for conservation of wildlife.

PIT VIPERS

The 'pit' is a special organ in between the eyes and the nostrils. The pit senses body heat from animals and gives the snake a 'picture' of that animal. The snake can then attack it. This helps these snakes to find prey in the dark.

Some pit vipers will bite and poison the prey and then release it. It will follow the dying animal, using its heat sensors, until it stops and the snake can swallow it. Most pit vipers hunt at night when the air is cooler and the heat from rodents and other prey is most obvious to them. All rattlesnakes are Pit Vipers.

◆◆◆◆◆◆

CHAPTER - 8

INDIAN BIODIVERSITY DIVERSE LANDSCAPE

India is one of the recognized megadiverse countries of the world. In terms of species richness, India ranks seventh in mammals, ninth in birds and fifth in reptiles. In terms of endemism of vertebrate groups, India's position is tenth in birds with 69 species, fifth in reptiles with 156 species and seventh in amphibians with 110 species.

India's share of crops is 44% as compared to the world average of 11%. India also has 23.39% of its geographical area under forest and tree cover. Of the 34 globally identified biodiversity hotspots, India harbours two hotspots, i.e., Eastern Himalayas, Western Ghats and Sri Lanka

The varied Edaphic, Climatic and Topographic conditions have resulted in a wide range of ecosystems and habitats such as forests, grasslands, wetlands, coastal and marine ecosystems, and deserts in India with greater biodiversity.

Do you know?

The spider's body has an oil on it to keep the spider free from sticking to it's own web.

8.1. INDIA REPRESENTS:

a) Two 'Realms

b) Five Biomes

c) Ten Bio-geographic Zones

d) Twenty five Bio-geographic provinces

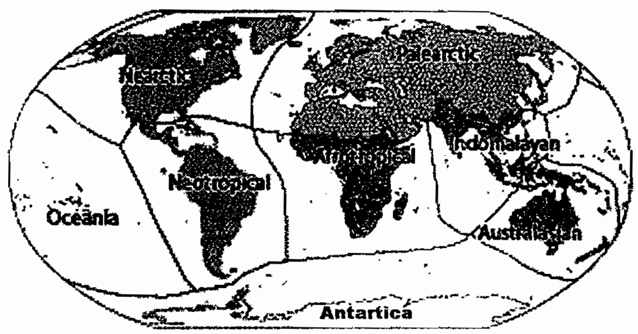
a) Realms :

Biogeographic realms are large spatial regions within which ecosystems share a broadly similar biota. Realm is a continent or sub continent sized area with unifying features of geography and fauna & flora.

The Indian region is composed of two realms. They are:

1) the Himalayan region represented by Palearctic Realm and

2) the rest of the sub-continent represented by Malayan Realm



Realm

In world Eight terrestrial biogeographic realms are typically recognized. They are

1. nearctic realm
2. palaearctic realm
3. africotropical realm
4. indomalayan realm
5. ocenaia realm
6. Australian realm
7. Antarctic realm
8. Neotropical realm

b) Biomes of India :

The term biome means the main groups of plants and animals living in areas of certain climate patterns. It includes the way in which animals, vegetation and soil interact together. The plants and animals of that area have adapted to that environment. The five biomes of India are:

1) Tropical Humid Forests

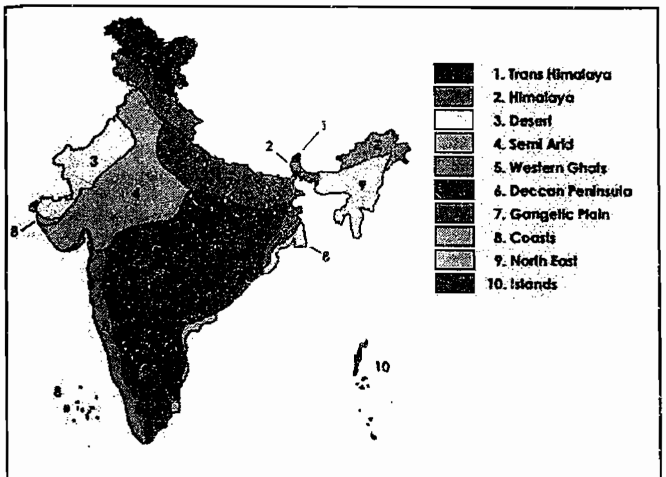
2) Tropical Dry or Deciduous Forests (including Monsoon Forests)

3) Warm deserts and semi-deserts

4) Coniferous forests and

5) Alpine meadows.

c) Bio-geographic Zones :



Bio-geographic Zones India

Biogeography deals with the geographical distribution of plants and animals. There are 10 biogeographic zones which are distinguished clearly in India. They are as follows—

1) Trans-Himalayas. An extension of the Tibetan plateau, harboring high-altitude cold desert in Laddakh (J&K) and Lahaul Spiti (H.P) comprising 5.7 % of the country's landmass.
2) Himalayas. The entire mountain chain running from north-western to northeastern India, comprising a diverse range of biotic provinces and biomes, 7.2 % of the country's landmass.
3) Desert. The extremely arid area west of the Aravalli hill range, comprising both the salty desert of Gujarat and the sand desert of Rajasthan. 6.9% of the country's landmass.
4) Semi-arid. The zone between the desert and the Deccan plateau, including the Aravalli hill range. 15.6 % of the country's landmass.
5) Western ghats. The hill ranges and plains running along the western coastline, south of the Tapti river, covering an extremely diverse range of biotic provinces and biomes. 5.8% of the country's landmass.
6) Deccan peninsula. The largest of the zones, covering much of the southern and southcentral plateau with a predominantly deciduous vegetation. 4.3 % of the country's landmass.
7) Gangetic plain. Defined by the Ganges river system, these plains are relatively homogenous. 11% of the country's landmass.
8) North-east India. The plains and non-Himalayan hill ranges of northeastern India, with a wide variation of vegetation. 5.2% of the country's landmass.
9) Islands. The Andaman and Nicobar Islands in the Bay of Bengal, with a highly diverse set of biomes. 0.03% of the country's landmass.
10) Coasts. A large coastline distributed both to the west and east, with distinct differences between the two; Lakshadeep islands are included in this with the percent area being negligible.

Biogeography is divided into branches:

i. Phyto-geography (plant geography) deals with origin, distribution and environmental interrelationships of plants.
ii. Zoogeography deals with the migration and distribution of animals.

d) Bio-geographic provinces.

Bio-geographic Province is a ecosystematic or biotic subdivision of realms. India is divided into 25 bio geographic zones.

Biogeographic classification of India was done by Rodgers and Panwar (1988), describing 10 biogeographic zones in India, further divided into 25 biogeographic provinces. The classification was done using various factors such as altitude, moisture, topography, rainfall, etc. Biogeographic zones were used as a basis for planning wildlife protected areas in India.

8.1.1. Biogeographic zones and Biogeographic Provinces of India

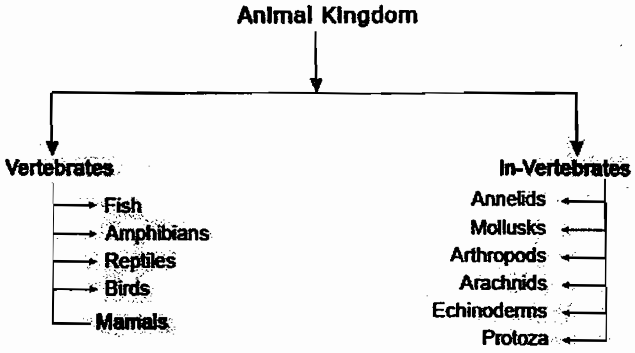
S.No.	**Biogeographic Zones (10 nos)**	Biogeographic Provinces (25 nos)
1.	Trans Himalaya	1A:Himalaya -Ladakh Mountains 1B: Himalaya -Tibetan Plateau 1C: Trans - Himalaya Sikkim
2.	The Himalaya	2A:Himalaya - North West Himalaya 2B: Himalaya - West Himalaya 2C: Himalaya - Central Himalaya 2D:Himalaya - East Himalaya

3.	The Indian Desert	3A: Desert – Thar 3B: Desert – Katchchh
4.	The Semi Arid	4A: Semi - Arid - Punjab Plains 4B: Semi - Arid - Gujarat Rajputana
5.	The Western Ghats	5A: Western Ghats - Malabar Plains 5B: Western Ghats -Western Ghats Mountains
6.	The Deccan Peninsula	6A: Deccan Peninsular - Central Highlands 6B: Deccan Peninsular - Chotta Nagpur 6C: Deccan Peninsular - Eastern Highlands 6D: Deccan Peninsular - Central Plateau 6E: Deccan Peninsular - Deccan South
7.	The Gangetic Plains	7A: Gangetic Plain - Upper Gangetic Plains 7B: Gangetic Plain - Lower Gangetic Plains
8.	The Coasts	8A: Coasts - West Coast 8B: Coasts - East Coast 8C: Coasts – Lakshdweep
9.	Northeast India	9A: North - East - Brahamputra Valley 9B: North - East – North East Hills
10.	Islands	10A: Islands – Andamans 10B: Islands – Nicobars

Do you know?

Wrinkles help elephants keep their body temperature down. Wrinkles increase the surface area, so that more skin becomes wet when the animal bathes. All the cracks and crevices trap moisture, which then takes much longer to evaporate. A wrinkly elephant keeps cooler for longer than it would with smooth skin.

8.2. FAUNA

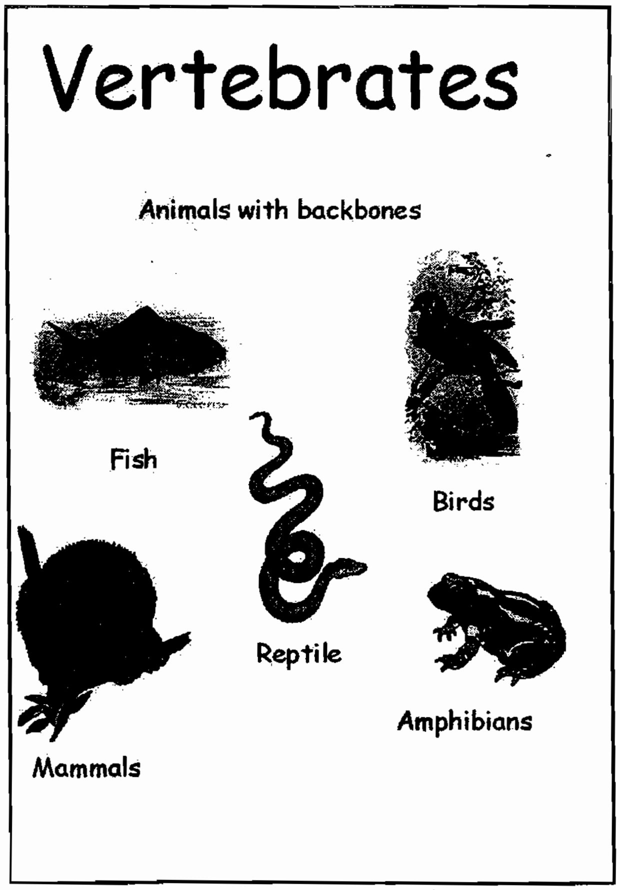

Animal Kingdom
Vertebrates
Fish
Amphibians
Reptiles
Birds
Mamals
In-Vertebrates
Annelids
Mollusks
Arthropods
Arachnids
Echinoderms
Protoza

Do you know?

Eels are sometimes mistaken for Sea Snakes. Eels are part of the fish family and have gills for breathing. Sea snakes do not have gills but lungs instead and need to go to the surface for air.)

8.2.1. Vertebrates

Vertebrates are animals with backbones and spinal columns. Vertebrates are the most advanced organisms on Earth. Although vertebrates represent only a very small percentage of all animals, their size and mobility often allow them to dominate their environment.


Vertebrates
Animals with backbones
Fish
Birds
Reptile
Amphibians
Mammals

Fishes

- Cold blooded
- Live in water
- Breathe under water using gills , not lungs
- Have scales and fins
- Lay many eggs

Amphibians

- Cold blooded
- Live on land & water
- Webbed feet
- Breathe with lungs and gills
- Moist smooth skin
- Four legs (sometimes none)
- Lay many eggs

Reptiles

- Cold blooded
- Have scales
- Have dry skin
- Usually lay eggs
- Ear holes instead of ears
- 4 legs or no legs

Aves

- Warm blooded
- Have feathers and wings
- Lay eggs
- Have 2 legs
- Ear holes instead of ears

Mammals

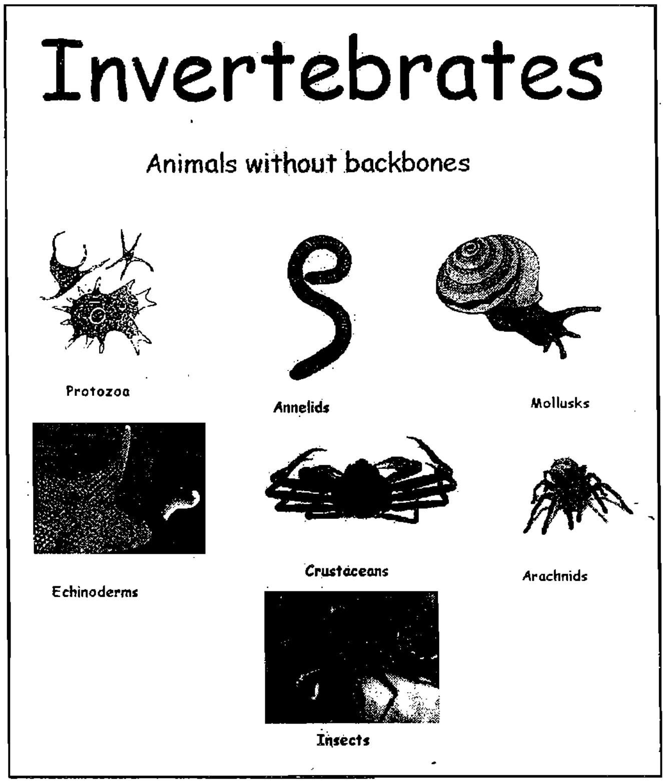
- Warm blooded
- Have hair or fur
- Give birth to live young
- Mammal mother nurse their young one with milk
- Breathe with lungs
- Mammals live on land have 4 legs (or 2 legs & 2 arms), and ears that stick out.

Do you know?

Elephants' ears act as cooling devices. They can measure up to 2 square metres and they are equipped with an intricate web of blood vessels. When the animal flaps its ears, the blood temperature lowers by as much as 5°C.

8.2.2. Invertebrates

Invertebrates do not have backbones. More than 98% animal species in the world are invertebrates. Invertebrates don't have an internal skeleton made of bone. Many invertebrates have a fluid-filled, hydrostatic skeleton, like the jelly fish or worm. Others have a hard outer shell, like insects and crustaceans.



Annelids

- Annelids have bodies that are divided into segments.
- They have very well-developed internal organs.
- Found almost anywhere in the world.
- They don't have any limbs.
- E.g: earthworms, leeches, roundworms, etc.

Mollusks

- Most mollusks have a soft, skin-like organ covered with a hard outside shell.
- Some mollusks live on land, such as the snail and slug.
- Other mollusks live in water, such as the oyster, mussel, clam, squid and octopus.

Echinoderms

- Echinoderms are marine animals that live in the ocean.

- Most echinoderms have arms or spines that radiate from the center of their body.
- Common echinoderms include the sea star, sea urchin, sand dollar and sea cucumber.

Protozoa

- Protozoa are simple, single-celled animals.
- They are the smallest of all animals.
- Most protozoa are microscopic.
- They do breathe, move and reproduce like multicelled animals.
- E.g: amoebas, Flagellates,etc.

Arthropods

- Arthropods have limbs with joints that allow them to move.
- They also have an exoskeleton, which is a hard, external skeleton.
- Arthropods include the crustaceans and insects, arachnids.

Crustaceans

- live mostly in the ocean or other waters.
- Crustaceans have a hard, external shell which protects their body
- Most commonly known crustaceans are the crab, lobster and barnacle.

Insects

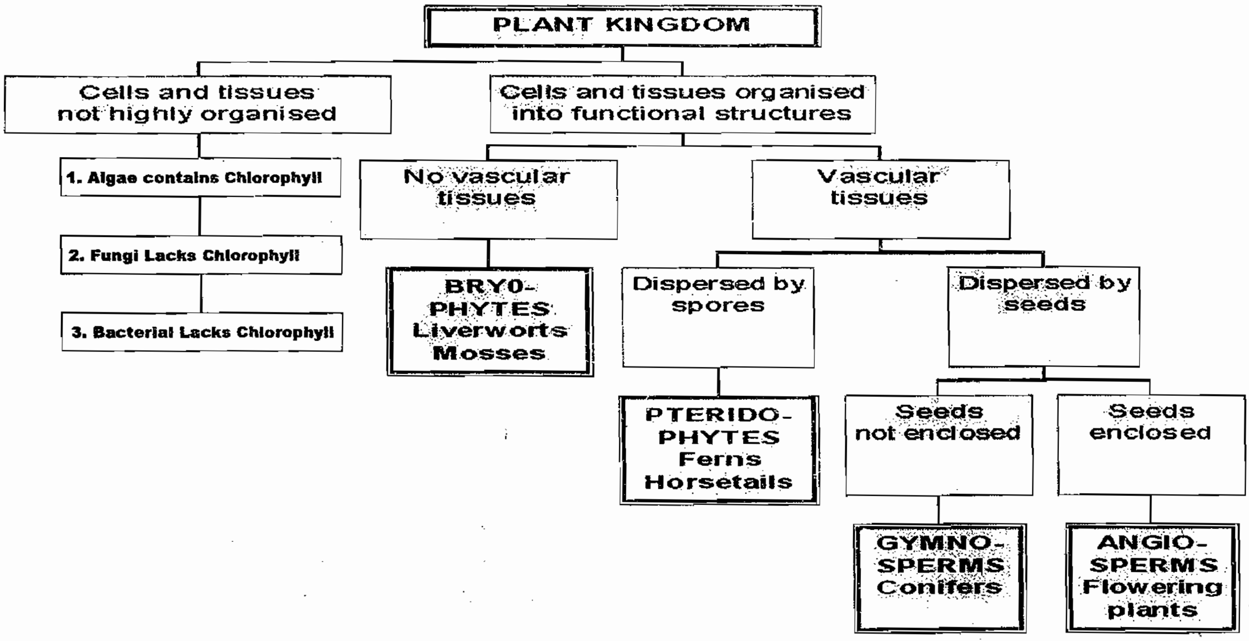
- Insects are very adaptable, living almost everywhere in the world.
- Insects have an exoskeleton that covers their entire body.
- An insect's consists of 3 body parts and 6 legs and a antennae
- E.g: fly, beetle, butterfly, moth, dragonfly, bee, wasp and praying mantis.

Arachnids

- Common arachnids are spiders, scorpions, ticks and mites.
- Arachnids do not have antennae.
- Arachnids have 2 body parts and 4 pairs of legs.

8.3. FLORAL DIVERSITY

In terms of plant diversity, India ranks tenth in the world and fourth in Asia. India represents nearly 11% of the world's known floral diversity.


PLANT KINGDOM
Cells and tissues not highly organised
Cells and tissues organised into functional structures
1. Algae contains Chlorophyll
2. Fungi Lacks Chlorophyll
3. Bacterial Lacks Chlorophyll
No vascular tissues
Vascular tissues
BRYO-PHYTES Liverworts Mosses
Dispersed by spores
Dispersed by seeds
PTERIDO-PHYTES Ferns Horsetails
Seeds not enclosed
Seeds enclosed
GYMNO-SPERMS Conifers
ANGIO-SPERMS Flowering plants

Do you know?

Polar bears are marvellously adapted to their Arctic surroundings. Their glossy 'guard' hairs and dense under-fur, the thick layer of fat beneath their skin, and their size protect them against the cold. The guard hairs shed water easily, so that after a swim the polar bear can shake itself like a dog to dry and warm itself quickly.

8.3.1. Important floral groups found in India are described below:

1. Algae

The green non differentiated plants (non - differentiated into organs like root, stem and leaf.) possessing chlorophyll are known as Algae. They usually grow in water or in moist situations.

The fresh-water algae are generally green or blue-green in colour, whereas the marine ones are red or brown. These are autotrophic plants, as they can manufacture their own food.

2. Fungi:

Non-green non differentiated plants characterised by total absence of chlorophyll are called Fungi.

They grow either on dead, rotten organic matters as saprophytes or live as parasites on other living bodies, which are referred to as hosts.

Moulds and mushrooms are the familiar examples of saprophytic fungi. The maximum diversity of fungi is in the Western Ghats followed by the eastern Himalaya and the western Himalaya. About 3500 species are endemic to the country.

3. Bacteria

Non-chlorophyllous micro-organisms which lead saprophytic or parasitic existence. Many of them are pathogenic; Saprophytic bacteria are rather beneficial. They are soil borne and many of them are used in industries.

4. Lichens

A lichen is a peculiar combination of an alga and a fungus–the two live deriving mutual benefit.

They are group of greyish green plants which grow on rocks, three-trunks, dead wood, etc.

The algae manufactures carbohydrate food which becomes available to the fungus, and the latter absorbs and retains water and thus keeps the algal cells moist. So it is a nice example of symbiosis.

They are most common in wetlands, rare in rivers and streams and are not found in ground water.

5. Bryophytes

The plant body is differentiated into a small stem and simple leaves, but true roots are absent.

They usually grow in moist places. E.g. Liverworts, mosses

They are the second largest group of green plants in India distributed largely in Eastern Himalaya, North-eastern India, Western Himalaya and the Western Ghats.

Mosses constitute the major component of Indian bryoflora followed by liverworts and hornworts.

6. Pteridophytes

The pteridophytes have well-differentiated plant bodies, consisting of roots, stems and leaves. Moreover, they possess vascular bundles.

Most of them are terrestrial plants flourishing well in moist and shady places, and some of them are aquatic.

This group includes the vascular cryptogams like club-mosses, horse-tails and ferns which are universally distributed all over the world.

The north-eastern region (including Eastern Himalaya) is rich in pteridophytic diversity, followed by south India (including Eastern and Western Ghats) and north India (including Western Himalaya).

7. Gymnosperms

Gymnosperms (gymnos=naked, sperma=seed) are the naked-seeded plants.

They have very simple flowers without accessory whorls and the microsporophylls (stamens) and megasporophylls (carpels) remain aggregated in cones.

Ovules are present on the surface of the megasporophylls and are directly pollinated by the pollen grains.

There is nothing like ovary, style and stigma, and naturally there is no fruit.

e.g. Cycas, Pinus, Gnetum.

Pinaceae is the largest family, followed by Cupressaceae, etc. The species of Gnetum and Cycas are mostly confined to North Eastern region, Eastern and Western Ghats, and Andaman & Nicobar Islands.

Do you know?

Polar bears evolved relatively recently (about 200,000 years to possibly as long as 500,000 years ago) from grizzly bears somewhere off eastern Russia or the Alaskan Panhandle. They depend on sea ice for their primary habitat for their food (mainly ringed seals and bearded seals). As the world's oceans have never been frozen from the north to the south, polar bears simply didn't have the possibility to reach the Antarctic, although it would have been a perfect home for them.

8. Angiosperms:

Angiosperms (angeion=a case) are the closed-seeded plants.

These are the most highly developed plants which bear flowers having conspicuous accessory and essential whorls. Carpels have the ovary, style and stigma.

With the stimulus of fertilization the ovary usually develops into the fruit and the ovules into seeds. Thus the seeds remain within the fruits.

India has more than 7% of the world's known flowering plants.

8.3.2. Floral endemism

1) peninsular India including western and Eastern Ghats (about 2,600 species),
2) Eastern Himalaya and north-eastern region (about 2,500 species),
3) north-western Himalaya (about 800 species) and
4) Andaman & Nicobar Islands (about 250 species).

8.3.3. Crop genetic diversity

Agriculture remains one of the dominant drivers and mainstay of economic growth in India. The large mosaic of distinct agro-ecosystems, characterized by variations in edaphic, climatic and geographic features, has contributed to diverse cropping patterns and systems across the country.

India stands seventh in the world in terms of contribution of species to agriculture and animal husbandry.

The national gene bank at National Bureau Of Plant Genetic Resources (NBPGR), Delhi is primarily responsible for conservation of unique accessions on long-term basis, as base collections for posterity, predominantly in the form of seeds.

8.3.4. Livestock genetic diversity

India has vast resources of livestock and poultry, which play a vital role in rural livelihood security. In terms of population, India ranks first in buffaloes, second in cattle and goats, third in sheep, fourth in ducks, fifth in chicken and sixth in camels in the world.

The genetic resources of farm animals in India are represented by a broad spectrum of native breeds of cattle, buffaloes, goats, sheep, swine, equines, camel and poultry.

Over the years, animal husbandry has intensified in India with widespread introduction of exotic breeds. This has led to the reduction in total genetic variability and population size of many local breeds. The majority (85%) of the domestic livestock in India is reared under low input production systems.

Do you know?

The name 'white rhinoceros' is taken from the Afrikaans word describing its mouth: "weit", meaning "wide". Early English settlers in South Africa misinterpreted the "weit" for "white".

White rhinos are also sometimes called 'the square-lipped rhinoceros'. Their upper lip lacks the prehensile 'hook' of some of the other rhino species. The white rhino is the largest species of land mammal after the elephant.

8.4. WILDLIFE OF INDIA

8.4.1. Himalayan mountain system

The west Himalayas have low rainfall, heavy snowfall (temperate conditions), whereas in east Himalayas, there is heavy rainfall, snowfall only at very high altitudes, where as at lower altitudes conditions are similar to the tropical rain forests. Flora and fauna of both Himalayas differ.

(1) Himalayan foothills

Flora : Natural monsoon evergreen and semi-evergreen forests; dominant species are sal, silk-cotton trees, giant bamboos; tall grassy meadow with savannahs in tarai.

Fauna : Includes big mammals of like elephant, sambar, swamp deer, cheetal, hog deer, barking deer, wild boar tiger, panther, wild dogs, hyena, black bear, sloth bear, porcupine, Great Indian one-horned rhinoceros, wild buffalo, gangetic gharial, golden langur.

(2) Western Himalayas (High altitude region)

Flora : Natural monsoon evergreen and semi-evergreen forests; rhododendrons; dwarf hill bamboo and birch forests mixed with alpine pastures.

Fauna : Wild ass, wild goats (thar, markhor, ibex) and sheep (Nayan, Marcopolo's sheep, bharal or blue sheep) ; antelopes (Chiru and Tibetan gazelle), deers (hangul of Kashmir stag and shou or Sikkim stag, musk deer); marmots and pikas or mouse hares; golden eagle, snow cocks, snow partridges; snow leopard, wolf, fox, cats, black and brown bears; birds like Himalayan monal pheasant, western trogopan, Koklass, whitecrested khalij cheer pleasant; Griffon vultures, lammergiers, choughs, ravens.

(3) Eastern Himalayas.

Flora. Oaks, magnolias, laurels and birches covered with moss and ferns; coniferous forests of pine, fir, yew and junipers with undergrowth of scrubby rhododendrons and dwarf bamboos; lichens, moses, orchids, and other epiphytes dominant (due to high humidity and high rainfall).

Fauna. Red panda, hog badgers forest badgers, crestless porcupines, goat antelopes (Scrow, Goral, Takins).

8.4.2. Peninsular - Indian sub-region

It has two zones.

(i) peninsular India and its extension into the drainage basin of the Ganges river system, and

(ii) desert region of Rajasthan-the Thar of Indian desert region.

(1). Peninsular India.

It is home to tropical moist deciduous to tropical dry deciduous and scrub vegetation depending upon the variation in rainfall and humidity.

Flora : Sal in north and east extensions (higher rainfall) and teak in southern plateau are dominant trees. West Ghats have evergreen vegetation (flora and fauna similar to evergreen rainforests of north eastern of India. In dry areas of Rajasthan and Aravalli hills, trees are scattered and thorny scrub species predominate. The forests give way to more open savannah habit.

Fauna : Elephant, wild boar, deers (cheetal or axis deer), hog deer swamp deer or barasinga, sambar, muntjak or barking deer, antelopes (four-hourned antelope, nilgai, blackbuck, chinkara gazelle), wild dog or dhole, tiger, leopard, cheetah, lion, wild pig, monkey, striped hyena, jackal, gaur.

Do you know?

polar bears have the ability to slow down their metabolism, after 7-10 days of not being able to feed, for whatever reason and at any time of year, until food becomes available again. This helps them adapt to the uncertainties of food availability in the Arctic. In comparison, black or brown bears can slow down their metabolism only in response to not feeding in the late autumn, just before they enter their dens for the winter. If food is not available in spring or summer, they will simply starve to death.

(2) Indian desert.

Thar desert of Rajasthan has unique flora and fauna.

Flora : Throny trees with reduced leaves; cacti, other succulents are the main plants.

Fauna : Animals are mostly burrowing ones. Among mammals rodents are the largest group. The Indian desert gerbils are mouse like, rodents, other animals are, wild ass, black buck, desert cat, caracal, red fox; reptiles (snackes, lizards and tortoise) well represented. Desert lizards include agamids, lacertids and geckos. Among birds the most discussed is Great Indian bustard.

8.4.3. Tropical rain forest region

Distributed in areas of western ghats and north east India.

Flora : Extensive grass lands interspersed with densely forested gorges of evergreen vegetation known as sholas occur in the Nilgiris (an offshoot of Western ghats). Sholas also occur in Aanaimalai and Palani hills. The rain forests of the Western ghats have dense and lofty trees with much species diversity. Mosses, ferns, epiphytes, orchids, lianas and vines, herbs, shrubs make diverse habitat. Ebony trees predominate in these forests. A variety of tropical orchids are found. Stratification in rain forests is very distinct-three horizontal layers are distinguished.

Fauna : It is very rich with all kinds of animals. There are wild elephants, gaur and other larger animals. Most species are tree dwellers. The most prominent are hoolock gibbon (only ape found in India), golden langur, capped langur or leaf monkey, Assam macaque and the pig-tailed macaque, lion-tailed macaque, Nilgiri langur slender loris, bats, gaint squirrel, civets, flying squirrels, Nilgiri mongoose, spiny mouse.

8.4.4. Andaman and Nicobar Islands

Flora. These are home for tropical rain forests. Giant Dipterocarpus, Terminalia and Lagerstroemia are dominant. Mangroves are also distributed in the coastal areas.

Fauna. Many species (about 35) of mammals, a number of reptiles and marine animals occur in this area. Among mammals, bats and rats predominate (3/4th of the total mammals on islands) ; Andaman pig, crab-eating macaque, palm civet and deers (spotted deer, barking deer, hog deer, sambar). Among marine mammals there are dugong, false killer whale, dolphin. Among birds are rare one is Narcondum hornbill. Nicobar pigeon and megapode. There are also other birds like white-bellied sea-eagle, white-breasted swiftlet and several fruit pigeons.

Salt-water crocodile, a number of marine turtles, coconut crab, lizards (the largest being water monitor), 40 species of snakes including cobra, viper, voral and sea snake, python, etc are present.

Do you know?

Penguins are warm blooded, Just like whales, penguins have a layer of fat under their skin called "blubber". Overtop of this they are covered with fluffy "down" feathers and overtop of those they have their outer feathers which overlap to seal in warmth. Penguins rub oil from a gland onto their feathers to help make them waterproof and windproof.

8.4.5. Mangrove swamps of Sunderbans

Sunderbans are delta of the Ganges where both the Brahmaputra and Ganges join and drain into the Bay of Bengal.

Flora. The lower tidal zones are pioneer trees like Sonneratia and avicennia. Above this zone there are rhizophora, bruguiria and excaecaria-cereops forest (covering nearly 70% of mangrove forest). Above this level there are supporting forest of phoneix in association with excaecaria. There are heriteria forest in the highest portion with thick undergrowth of phoneix and neepa plams.

Fauna. Fish, small crabs, dorippe (the one that has unusual association with sea anemone), weaver ants. In the higher regions of mangroves, there are spotted deer, pigs, monitor lizard, monkeys. The most interesting animal of Sunderbans is the Royal Bengal Tiger.

◆ ◆ ◆

CHAPTER - 9

ANIMAL DIVERSITY OF INDIA

9.1. THE RED DATA BOOK

Species judged as threatened are listed by various agencies as well as by some private organizations. The most cited of these lists is the Red Data Book.

It is a loose-leaf volume of information on the status of many kinds of species. This volume is continually updated and is issued by the International Union for Conservation of Nature (IUCN) located in Morges, Switzerland.

"Red" of course is symbolic of danger that the species both plants and animals presently experience throughout the globe.

The Red Data Book was first issued in 1966 by the IUCN's Special Survival Commission as a guide for formulation, preservation and management of species listed.

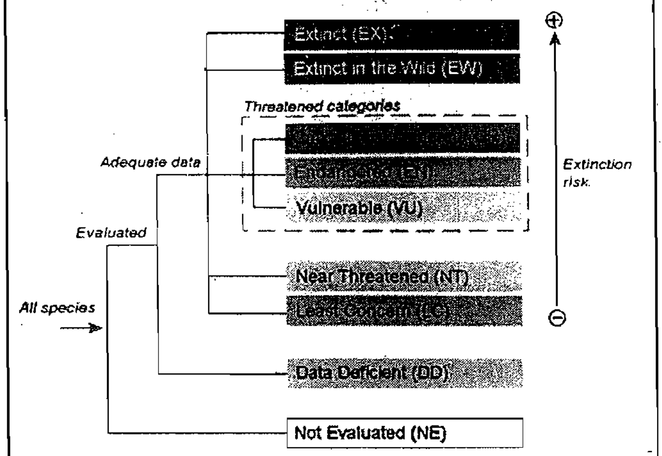
In this Book, information for endangered mammals and birds are more extensive than for other groups of animals and plants, coverage is also given to less prominent organisms facing extinction.

The pink pages in this publication include the critically endangered species. As the status of the species changes, new pages are sent to the subscribers.

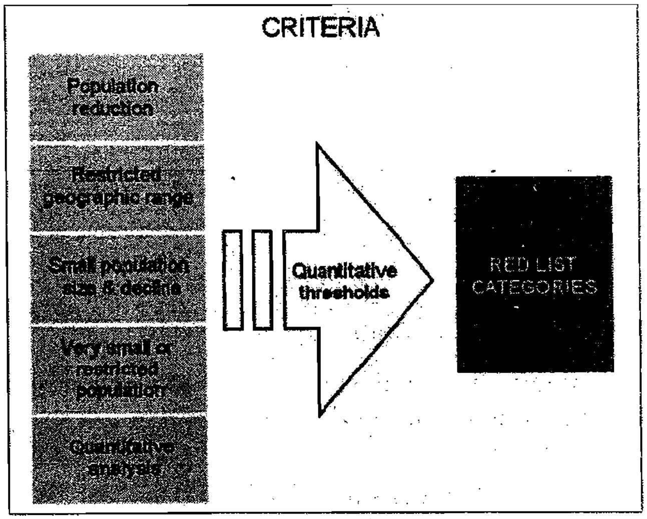
Green pages are used for those species that were formerly endangered, but have now recovered to a point where they are no longer threatened. With passing time, the number of pink pages continue to increase. There are pitifully few green pages.

Do you know?

Two species of bear which have special feet are polar bear and the giant panda. The polar bear has partially webbed toes for swimming and walking on snow as well as furry bottoms to keep its feet warm on the ice. Giant pandas do not have a heel pad so they walk more on their toes.


Extinct (EX)
Extinct in the Wild (EW)
Threatened categories
Endangered (EN)
Vulnerable (VU)
Adequate data
Evaluated
All species
Near Threatened (NT)
Least Concern (LC)
Data Deficient (DD)
Not Evaluated (NE)
⊕
⊖
Extinction risk.

IUCN Categories


CRITERIA
Population reduction
Restricted geographic range
Small population size & decline
Very small or restricted population
Quantitative analysis
Quantitative thresholds
RED LIST CATEGORIES

9.2. IUCN CLASSIFICATION OF CONSERVATION PRIORITY

9.2.1. Extinct (EX)

A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual.

9.2.2. Extinct in the Wild (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual.

9.2.3. Critically Endangered (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria for Critically Endangered.

criteria

- reduction in population (> 90% over the last 10 years),
- population size (number less than 50 mature individuals),
- quantitative analysis showing the probability of extinction in wild in at least 50% in their 10 years) and
- it is therefore considered to be facing an extremely high risk of extinction in the wild.

9.2.4. Endangered (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria for Endangered.

criteria

- reduction in population size (70% over the last 10 years),
- population size estimated to number fewer than 250 mature individuals,
- quantitative analysis showing the probability of extinction in wild in at least 20% within 20 years and
- it is therefore considered to be facing a very high risk of extinction in the wild.

9.2.5. Vulnerable (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria for Vulnerable i.e.

criteria

- reduction in population (> 50% over the last 10 years)
- population size estimated to number fewer than 10,000 mature individuals,
- probability of extinction in wild is at least 10% within 100 years, and
- it is therefore considered to be facing a high risk of extinction in the wild.

9.2.6. Near Threatened (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

9.2.7. Least Concern (LC)

A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

9.2.8. Data Deficient (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking.

Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate.

9.2.9. Not Evaluated (NE)

A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

Do you know?

- India has been ranked as seventh most environmentally hazardous country in the world. The study is based on evaluation of "absolute" environment impact of 179 countries, done by researchers in Harvard, Princeton, Adelaide University and University of Singapore on January, 2011. Brazil was found to be worst on environmental indicators followed by united states and china whereas Singapore was the best.
- The National Clean Development Mechanism Authority of India evaluates and approves projects in accordance with guidelines issued by the Clean Development Mechanism Executive Board of the UNFCCC.

9.3. MAMMALS - CRITICALLY ENDANGERED

9.3.1. Pygmy Hog (Porcula salvania)

- Is the world's smallest wild pig, with adults weighing only 8 kgs. This species constructs a nest throughout the year.
- It is one of the most useful indicators of the management status of grassland habitats. The grasslands where the pygmy hog resides are crucial for the survival of other endangered species such as Indian Rhinoceros, Swamp Deer, Wild Buffalo, Hispid Hare, Bengal Florican and Swamp Francolin.
- In 1996, a captive-breeding programme of the species was initiated in Assam, and some hogs were reintroduced in Sonai Rupai area in 2009.
- Habitat: Relatively undisturbed, tall 'terai' grasslands.
- Distribution: Formerly, the species was more widely distributed along the southern Himalayan foothills but now is restricted to only a single remnant population in Manas Wildlife Sanctuary and its buffer reserves.
- Pygmy hog-sucking Louse (Haematopinus oliveri), a parasite that feeds only on Pygmy Hogs will also fall in the same risk category of critically endangered as its survival is linked to that of the host species.
- Threats: The main threats are loss and degradation of grasslands, dry-season burning, livestock grazing and afforestation of grasslands. Hunting is also a threat to the remnant populations.

9.3.2. Andaman White-toothed Shrew (Crocidura andamanensis), Jenkin's Andaman Spiny Shrew

- (Crocidura jenkinsi) and the Nicobar White-tailed Shrew (Crocidura nicobarica) Endemic to India.
- They are usually active by twilight or in the night and have specialized habitat requirements.
- Habitat: Leaf litter and rock crevices.
- Distribution:
  - The Andaman White-toothed Shrew is found on Mount Harriet in the South Andaman Islands.
  - The Jenkin's Andaman Spiny Shrew is found on Wright Myo and Mount Harriet in the South Andaman Islands.
- The Nicobar White-tailed Shrew (Crocidura nicobarica) is found in the southern tip of Greater Nicobar Island and is also recorded in the area extending from the Campbell Bay National Park to the Galathea River in the Andaman and Nicobar Islands.
- Threats: Habitat loss due to selective logging, natural disasters such as the tsunami and drastic weather changes.

9.3.3. Kondana Rat (Millardia kondana)

- It is a nocturnal burrowing rodent that is found only in India. It is sometimes known to build nests.
- Habitat: Tropical and subtropical dry deciduous forests and tropical scrub.
- Distribution: Known only from the small Sinhagarh Plateau (about one km²), near Pune in Maharashtra. Reported from an elevation of about 1,270 m above mean sea level.
- Threats: Major threats are habitat loss, overgrazing of vegetation and disturbance from tourism and recreational activities.

9.3.4. The Large Rock Rat or Elvira Rat (Cremnomys elvira)

- It is a medium sized, nocturnal and burrowing rodent. endemic to India.
- Habitat: Tropical dry deciduous shrubland forest, seen in rocky areas.
- Habitat / distribution: Known only from Eastern Ghats of Tamil Nadu. Recorded from an elevation of about 600 m above mean sea level.
- Threats: Major threats are habitat loss, conversion of forests and fuel wood collection.

Do you know?

India is endowed with vast inland and marine bio-resources. It is the third largest producer of fish in the world and the second largest producer of inland fish. The Western Ghats (the aquatic hotspot) has 192 endemic species of fishes

9.3.5. The Namdapha Flying Squirrel (Biswamoyopterus biswasi)

- It is a unique (the only one in its genus) flying squirrel that is restricted to a single valley in the Namdapha N.P. (or) W.L.S. in Arunachal Pradesh.
- Habitat: Tropical forest.
- Habitat / distribution: Found only in Namdapha Tiger Reserve in Arunachal Pradesh.
- Threats: Hunted for food.

9.3.6. The Malabar Civet (Viverra civettina)

- It is considered to be one of the world's rarest mammals.
- It is endemic to India and was first reported from Travancore, Kerala.
- It is nocturnal in nature and found exclusively in the Western Ghats.
- Habitat: Wooded plains and hill slopes of evergreen rainforests.
- Habitat / distribution: Western Ghats.
- Threats: Deforestation and commercial plantations are major threats.

Do you know?

The Spitting Cobra spits venom which can spray more than 1.8 meters, or 6 feet. It has near perfect aim, and will fire straight into the eyes of it's prey.

9.3.7. The Sumatran Rhinoceros (Dicerorhinus sumatrensis)

- It is the smallest and most endangered of the five rhinoceros species.
- It is now thought to be regionally extinct in India, though it once occurred in the foothills of the Himalayas and north-east India.
- The Javan Rhinoceros (Rhinoceros sondaicus) is also believed to be extinct in India and only a small number survive in Java and Vietnam.

9.3.8. Kashmir stag/ hangul (Cervus elaphus hanglu)

- It subspecies of Red Deer which is native to India.
- Habitat / distribution - in dense riverine forests, high valleys, and mountains of the Kashmir valley and northern Chamba in Himachal Pradesh.
- State animal of J&k.
- Threat - habitat destruction, over-grazing by domestic livestock, and poaching.

Do you know?

Penguins don't live near freshwater. they drink salt water. They have a special gland in their bodies that takes the salt out of the water they drink and pushes it out of grooves in their bill. A handy in-house filtration system!

9.4. MAMMALS - ENDANGERED

9.4.1. Wild ass/ khur (Equus hemionus khur)

- Once extended from western India, southern Pakistan, Afghanistan, and south-eastern Iran. Today, its last refuge lies in the Indian Wild Ass Sanctuary, Little Rann of Kutch.
- Threat –
  - Diseases- in 1958-1960, surra disease, caused by Trypanosoma evansi and transmitted by flies,
  - In 1961 outbreak of South African Horse Sickness.
  - other threats include habitat degradation due to salt activities, the invasion of the Prosopis juliflora shrub, and encroachment and grazing by the Maldhari.

9.4.2. Dhole/ Asiatic wild dog or Indian wild dog (Cuon alpinus)

- Threat - habitat loss, depletion of its prey base, competition from other predators, persecution and possibly diseases from domestic and feral dogs

9.4.3. Eld's deer/ thamin or brow-antlered deer (Panolia eldii)

- Status - endangered , deer indigenous to Southeast Asia
- Found in the Keibul Lamjao National Park (KLNP), Manipur.

9.4.4. Himalayan Brown/ red Bear (Ursus arctos isabellinus).

- Status – endangered.
- India's largest animals in the Himalayas, omnivores. Himalayan Brown Bears exhibit sexual dimorphism.
- Distribution - Nepal, Pakistan, and Northern India.

9.4.5. Golden langur (Trachypithecus geei)

- Primate, is an Old World monkey
- Distribution - small region of western Assam and in the neighboring foothills of the Black Mountains of Bhutan.
- Status- endangered.

Do you know?

Frog's tongues are attached to the front of their mouths rather than at the back like humans. When a frog catches an insect it throws its sticky tongue out of it's mouth and wraps it around its prey. The frog's tongue then snaps back and throws the food down its throat.

9.4.6. Himalayan wolf

- Habitat / distribution - trans-Himalayan region of Himachal Pradesh, Jammu and Kashmir in northern India.
- Status – Endangered

9.4.7. Himalayan / White-bellied Musk Deer

- Habitat / distribution - Kashmir, Kumaon and Sikkim.
- Musk deer lack antlers, but they possess a pair of enlarged canines that grow continuously.
- Status – endangered
- Threat - poaching & illegal trade for its musk
- Deer musk is a substance with a persistent odor obtained from a gland of the male musk deer (Only males produce the musk). The substance has been used as a perfume fixative, incense material, and medicine.

9.4.8. Hispid hare/ Assam rabbit (Caprolagus hispidus)

- Habitat / distribution - southern foothills of the central Himalayas. Status – endangered.
- The habitat of hispid hares is highly fragmented due to increasing agriculture, flood control, and human development.

Do you know?

Cobras are cannibals, which mean that they will eat other snakes along birds, bird eggs and small mammals

9.4.9. Hog deer

- Status - endangerd
- Habitat / distribution - northern india.
- Name - The hog deer runs through the forests with its head hung low (hog-like manner) so that it duck under obstacles instead of leaping over them like most other deer do.

9.4.10. Lion-tailed macaque/ wanderoo (Macaca silenus)

- Endemic to the Western Ghats.
- Status – endangered. Avoid human presence and they do not live, feed or travel through plantations.
- Habitat: Lion-tailed macaques live in southwest India in pockets of evergreen forests, called sholas, in the Western Ghats range. Today, they only live in mountain forests scattered across three Indian states: Karnataka, Kerala, and Tamil Nadu.
- Threat - habitat fragmentation due to spread of agriculture and tea, coffee, teak and cinchona, construction of water reservoirs and human settlements to support such activities.
- Captive breeding – aringnar anna zoological park, Chennai and in Mysore Zoo.

9.4.10. Markhor (Capra falconeri)

- Exhibit sexual dimorphism national animal of Pakistan.
- Habitat / distribution –mountains of central Asia. In India - some parts of jammu and Kashmir .
- Status – endangered
- Threat – hunting (both for meat and for its twisted horns), armed conflict and habitat loss
- Conservation - listed on Appendix I of CITES

9.4.11 Nilgiri langur/ Nilgiri leaf monkey (Trachypithecus johnii)

- Status – endangered
- Threat – habitat degradation, development activites, introduction of exotic tree species.
- Habitat / distribution – hilly areas of western ghats in tamil nadu and kerala. tropical wet evergreen, semi-evergreen and riparian forests.

9.4.12. Nilgiri tahr

- The Nilgiri tahr is the largest of the three tahr species, inhabit montane grasslands of western ghats.
- It is the state animal of Tamil nadu. Status in the Wild: Endangered
- shoals forest (stunted evergreen forests) are typically avoided by tahr.
- Threats- habitat loss, overgrazing, illegal hunting.

9.4.13. Great Indian one horn Rhinoceros

- Habitat: Found only in the tall grasslands and forests in the foothills of the Himalayas.
- National Parks: Kaziranga National Park, pabitora wildlife sanctuary, Manas National Park, Assam
- Status in the Wild: Endangered
- Threat - Oriental belief that its horn, among other parts, has medicinal properties.

9.4.14. Wild Ass

- Habitat: Flat grassland covered expanse known as bets (islands where coarse grasses springs up during the monsoon).
- National Parks: Little Rann Of Kutch, Gujarat
- Status in the Wild: Endangered

9.5. VULNERABLE MAMMALS

9.5.1. Chiru / Tibetian Antelope

- Status – Vulnernable
- Habitat : Tibet cold desert
- Threat : The chiru is threatened by hunting for its fine wool which is used to make the shahtoosh scarves, meat, magnificent horns.

9.5.2. Himalayan tahr

- Status – vulnerable
- habitat – Himalayas
- tahr have many characters in common with true goats, but lack a beard and have several other unique features.

9.5.3. Black buck

- Status – vulnerable
- Habitat – Grass land
- Threat - excessive hunting for meat and sporting trophies, as well as habitat loss. Black buck show sexual dimorphism.

Do you know?

Sharks have the most powerful jaws on the planet. Both the upper and lower jaws move. It tosses its head back and forth to tear loose a piece of meat which it swallows whole.

9.5.4. Gaur

- The gaur (Bos gaurus), also called Indian bison, is a large bovine native to South Asia and Southeast Asia. The species is listed as vulnerable on the IUCN Red List.
- Gaur are largely confined to evergreen forests or semi-evergreen and moist deciduous forests, but also occur in deciduous forest areas at the periphery of their range.
- The domesticated form of the gaur, Bos frontalis, is called gayal or mithun

9.5.5. Four-horned antelope, Chousingha

- Status - vulnerable
- The four-horned antelope must drink water regularly in order to survive

9.5.6. Takin

- Status - vulnerable
- Mountainous regions in the Himalayan Mountains and western China

9.5.7. Nilgiri marten

- Endemic to the Western Ghats. inhabits areas that are far from human disturbance
- Semi-arboreal lifestyle. Martens are Carnivorous animal.
- Only species of marten considered vulnerable to extinction.
- Threat - habitat loss and fragmentation, hunting for its fur.
- Only species of marten found in southern India

9.5.8. Red Panda

- Red panda is endemic to the temperate forests of the Himalayas,
- Diet - omnivorous (mainly on bamboo).
- Habitat / distribution – Sikkim and assam, northern arunachal Pradesh.
- Threat - habitat loss and fragmentation, poaching, and inbreeding depression.

9.5.9. Marbled cat (Pardofelis marmorata)

- Habitat / distribution - from northern India and Nepal, through south-eastern Asia to Borneo and Sumatra
- In india - Sikkim, Darjeeling, moist tropical forest.
- Arboreal in nature
- Threat – hunting, habitat destruction for marbled cat and its prey.

9.5.10. Barasingha or swamp deer (Rucervus duvaucelii)

- Habitat / distribution - isolated localities in northern and central India, and southwestern Nepal.
- Status - vulnerable.

9.5.11. Indian wolf

- Habitat / distribution - range extends from south of the Himalayas
- Status – vulnerable

9.5.12. Oriental small-clawed otter/ Asian small-clawed otter (Aonyx cinerea),

- Otter - any of 13 living species of semiaquatic mammals which feed on fish and shellfish, and also other invertebrates, amphibians, birds and small mammals.

- It is a smallest otter species in the world
- It lives in mangrove swamps and freshwater wetlands.
- Status – vulnerable. Threat - habitat loss, pollution and hunting.

9.5.13. Clouded leopard (Neofelis nebulosa)

- Habitat / distribution - Himalayan foothills through mainland Southeast Asia into China,
- They occur in northern West Bengal, Sikkim, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura.
- status –vulnerable. Threat – deforestation and poaching.

9.5.14. Asian black bear/ moon bear or white-chested bear (Ursus thibetanus)

- medium-sized species of bear, largely adapted for arboreal life,
- Habitat / distribution - seen across much of the Himalayas, Korea, northeastern China, the Russian far east and the Honshū and Shikoku islands of Japan.
- Status -vulnerable species,
- Threat - deforestation and active hunting for its body parts.

Do you know?

- When male frogs are ready to mate they will 'call' out to the female frogs. Each different species of frog has their own special sound and that is the sound that the same species of female frog will answer to. Some frogs are so loud they can be heard a mile away!
- Frogs and toads are carnivores.
- Some frogs are very good at camouflaging themselves so that they blend in with their environment, making it harder for their enemies to find them. A frog can change the colour of its skin depending on its surroundings.

9.6. MARINE MAMMALS

9.6.1. Freshwater / river dolphin

- Habitat / distribution - India, Bangladesh, Nepal and Pakistan which is split into two subspecies, the Ganges river dolphin and Indus river dolphin.

9.6.2. Ganges river dolphin

- Habitat / distribution - Ganges and Brahmaputra Rivers and their tributaries in Bangladesh, India and Nepal.
- The Ganges river dolphin has been recognized by the government of India as its National Aquatic Animal.

9.6.3. Indus river dolphin

- Habitat / distribution - Indus River in Pakistan and its Beas and Sutlej tributaries.

9.6.4. Herbivorous Marine Mammals

- include dugong and manatees and they inhabit swamps, rivers, estuaries, marine wetlands, and coastal marine waters.

9.6.5. Dugong

- (Dugong dugon) also called as sea cow.
- Status - vulnerable. Threat - hunting (meat and oil), habitat degradation, and fishing-related fatalities.

9.6.6. Manatees

- Habitat / distribution - Caribbean Sea, Gulf of Mexico, the Amazon Basin, and West Africa
- Threat - coastal development, red tide, hunting.

9.7. FEW EXCEPTIONS

9.7.1. Egg Laying Mammals

The unique feature of monotremes, a sub division of mammal, is that monotremes lay eggs rather than giving birth to their young. There are only five living Monotreme/ egg laying Mammals species: they are - the duck-billed platypus and four species of spiny anteaters (also known as echidna). All of them are found only in Australia and New Guinea.

Echidnas are also known as spiny ant eaters.

- Habitat / distribution - Australia and New Guinea
- In echidnas, the egg is carried in a pouch on the female's belly until the young hatches, at which point the barely-developed young must find a mammary gland and latch onto it for nourishment.

Platypus is a semi-aquatic mammal.

- Habitat / distribution - endemic to eastern Australia, including Tasmania.
- In the platypus, the female retires to a burrow in the bank of a river or pond. The burrow is lined with dry vegetation, and there the eggs are laid.
- The male platypus has venom strong enough to can kill a small dog, or cause excruciating pain among humans.

9.7.2. Marsupials

- Marsupials are the group of mammals commonly thought of as pouched mammals (like the wallaby and kangaroo).
- Marsupial mammals have placenta but it is very short-lived and does not make as much of a contribution to fetal nourishment.
- They give birth very early and the young animal, essentially a helpless embryo, climbs from the mother's birth canal to the nipples.
- There it grabs on with its mouth and continues to develop, often for weeks or months depending on the species.
- They do not have long gestation times like placental mammals. The short gestation time is due to having a yolk-type placenta in the mother marsupial.
- Extinct - Marsupial - quagga, the marsupial wolf.
- Placental mammals all bear live young, which are nourished before birth in the mother's uterus through a specialized embryonic organ attached to the uterus wall, the placenta.
- Placental mammals nourish the developing embryo using the mother's blood supply, allowing longer gestation times.

List of Marsupials

Phalangers
Kola
Kangaroo
Wallaby
Wombats
Dasyure
Opossum
Tasmanian devils
Mursupial Mole (4 foot)
Bandi coot
Tasmanian Wolf /Tiger

9.7.3. Flying squirrel

- Flying squirrels are mammals too, but they don't really fly.
- They jump from high in a trees glide through the air like a kite.

Do you know?

Not all sharks are fierce carnivores. Some are quite harmless. Oddly enough, the most harmless sharks tend to be the largest! The basking shark, the whale shark and the Mega mouth sharks all fit this description. These huge sharks eat plankton.

9.8. BIRDS - CRITICALLY ENDANGERED

9.8.1. The Jerdon's Courser (Rhinoptilus bitorquatus)

- It is a nocturnal bird found only in the northern part of the state of Andhra Pradesh in peninsular India.
- It is a flagship species for the extremely threatened scrub jungle.
- The species was considered to be extinct until it was rediscovered in 1986 and the area of rediscovery was subsequently declared as the Sri Lankamaleswara Wildlife Sanctuary.
- Habitat: Undisturbed scrub jungle with open areas.
- Distribution: Jerdon's Courser is endemic to Andhra Pradesh.
- Threats: Clearing of scrub jungle, creation of new pastures, growing of dry land crops, Illegal trapping of birds, plantations of exotic trees, quarrying and the construction of the River Canals.

9.8.2. The Forest Owlet (Heteroglaux blewitti)

- Had been lost for more than a century. After 113 long years, the owlet was rediscovered in 1997 and reappeared on the list of Indian birds.
- Habitat: Dry deciduous forest.
- Habitat / distribution: South Madhya Pradesh, in north-west Maharashtra and north-central Maharashtra.
- Threats: Logging operations, burning and cutting of trees damage roosting and nesting trees of the Forest Owlet.

9.8.3. The White-bellied Heron (Ardea insignis)

- extremely rare bird found in five or six sites in Assam and Arunachal Pradesh, one or two sites in Bhutan, and a few in Myanmar.
- Habitat: Rivers with sand or gravel bars or inland lakes.
- Distribution: Bhutan and north-east India to the hills of Bangladesh and north Myanmar.
- Threats: Loss and degradation of lowland forests and wetlands through direct exploitation and disturbance by humans.

9.8.4. The Bengal Florican (Houbaropsis bengalensis)

- A rare bustard species that is very well known for its mating dance. Among the tall grasslands, secretive males advertise their territories by springing from the ground and flitting to and fro in the air.
- Habitat: Grasslands occasionally interspersed with scrublands.
- Distribution: Native to only 3 countries in the world - Cambodia, India and Nepal. In India, it occurs in 3 states, namely Uttar Pradesh, Assam and Arunachal Pradesh.
- Threats: Ongoing conversion of the bird's grassland habitat for various purposes including agriculture is mainly responsible for its population decline.

9.8.5. The Himalayan Quail (Ophrysia superciliosa)

- It is presumed to be extinct since no reliable records of sightings of this species exist after 1876. Intensive surveys are required as this species is hard to detect due to its reluctance to fly and its preference for dense grass habitats. Possible sighting of this species was reported in Nainital in 2003.
- Habitat: Tall grass and scrub on steep hillsides.
- Distribution: Western Himalayas.
- Threats: Indiscriminate hunting during the colonial period along with habitat modification.

9.8.6. Pink- headed Duck (Rhodonessa caryophyllacea)

- It has not been conclusively recorded in India since 1949. Males have a deep pink head and neck from which the bird derives its name.
- Habitat: Overgrown still-water pools, marshes and swamps in lowland forests and tall grasslands.
- Distribution: Recorded in India, Bangladesh and Myanmar. Maximum records are from north-east India.
- Threats: Wetland degradation and loss of habitat, along with hunting are the main causes of its decline.

9.8.7. Sociable Lapwing (Vanellus gregarious)

- It is a winter migrant to India. This species has suffered a sudden and rapid population decline due to which it has been listed as critically endangered.
- Habitat: Fallow fields and scrub desert.
- Distribution: central Asia, Asia Minor, Russia, Egypt, India, Pakistan. In India, habitat / distribution is restricted to the north and north-west of the country.
- Threats: Conversion of habitat to arable land, illegal hunting and proximity to human settlements.

Do you know?

Some trees can "talk" to each other. When willows are attacked by webworms and caterpillars, they emit a chemical that alerts nearby willow of the danger. The neighboring trees then respond by pumping more tannin into their leaves making it difficult for the insects to digest the leaves.

9.8.8. Spoon Billed Sandpiper (Eurynorhynchus pygmeus)

- It requires highly specialized breeding habitat, a constraint that has always kept its population scarce. India is home to some of the last existing wintering grounds of this species.
- Habitat: Coastal areas with sparse vegetation. No breeding records further inland than 7 km from the seashore.
- Distribution: Has been recorded in West Bengal, Orissa, Kerala and Tamil Nadu.
- Threats: Habitat degradation and land reclamation. Human disturbance also leads to high incidence of nest desertion.

9.8.9. Siberian Crane (Grus leucogeranus)

- It is a large, strikingly majestic migratory bird that breeds and winters in wetlands. They are known to winter at Keoladeo National Park, Rajasthan. However the last documented sighting of the bird was in 2002.
- Habitat: Wetland areas.
- Located distribution: Keoladeo National Park in Rajasthan.
- Threats: Pesticide pollution, wetland drainage, development of prime habitat into agricultural fields, and to some extent, hunting.

Do you know?

Since April, 2011 the Ministry of Environment and Forests (MoEF) has tightened pollution monitoring norms for power projects with a generation capacity of 500 Mw and above, and integrated steel plants with a capacity of 1 million tonnes per annum and cement plants with a capacity of 3 million tonnes per annum.

9.9. REPTILES - CRITICALLY ENDANGERED

9.9.1. Gharial (Gavialis gangeticus)

- It is the most uniquely evolved crocodilian in the world, a specialized, river-dwelling, fisheater.
- The dire condition of the gharial reflects the tragedy of our rivers, where we stand to not only lose other endangered taxa such as the Ganges River Dolphin (Platanista gangetica) but also the use of their waters for human consumption and other needs.
- Habitat: Clean rivers with sand banks.
- Distribution: Only viable population in the National Chambal Sanctuary, spread across three states of Uttar Pradesh, Rajasthan and Madhya Pradesh in India.
- Small non-breeding populations exist in Son, Gandak, Hoogly and Ghagra rivers. Now extinct in Myanmar, Pakistan, Bhutan and Bangladesh.
- Threats: The combined effects of dams, barrages, artificial embankments, change in river course, pollution, sand-mining, riparian agriculture and ingress of domestic and feral livestock caused irreversible loss of riverine habitat and consequently of the gharial.

9.9.2. Hawksbill Turtle (Eretmochelys imbricata)

- It is a heavily exploited species. The species is migratory in nature and nesting occurs in about 70 countries across the world. Maturation is slow and is estimated between 25 – 40 years.
- Habitat: Nesting occurs on insular, sandy beaches.
- Distribution: In India they are found in the Andaman and Nicobar Islands, the coast of Tamil Nadu and Orissa.
- Threats: Turtle shell trade, egg collection, slaughter for meat, oil pollution and destruction of nesting and foraging habitats.

9.9.3. Leatherback Turtle (Dermochelys coriacea)

- It is the largest of the living sea turtles, weighing as much as 900 kg.
- Adult leatherback turtles are excellent swimmers. They swim an average of 45-65 km a day, travel upto 15,000 km per year and can dive as deep as 1200 m. Jellyfish is their primary food.
- The population spikes of leatherback coincide with abundance of jellyfish, making them important top-predators in marine environments.
- Habitat: Tropical and subtropical oceans.
- Distribution: Found in tropical and temperate waters of the Atlantic, Pacific, and into Indian Oceans.
- Threats: High sea fishing operations, harvesting of eggs, destruction of nests by wild predators and domesticated species such as cats, dogs and pigs. Artificial lighting disorients hatchlings and adults and causes them to migrate inland rather than towards the sea. Threats to habitat include construction, mining and plantation of exotics.

9.9.4. Four-toed River Terrapin or River Terrapin (Batagur baska)

- It is a critically endangered turtle. The omnivorous diet of the river terrapin and other terrapin species makes them an essential part of the efficient clean-up systems of aquatic habitats.
- Habitat: Freshwater rivers and lakes.
- Distribution: Bangladesh, Cambodia, India, Indonesia and Malaysia.
- Threats: Use of flesh for medicinal purposes, demand for eggs, which are considered a delicacy.

9.9.5. Red-crowned Roofed Turtle or the Bengal Roof Turtle (Batagur kachuga)

- It is a critically endangered turtle mainly restricted to the Ganga basin. Males have a bright red coloration during the breeding season.
- Habitat: Deep, flowing rivers but with terrestrial nest sites.
- Distribution: Found in India, Bangladesh and Nepal. In India it resides basically in the watershed of the Ganga.
- Threats: Water development projects, water pollution, human disturbance and poaching for the illegal wildlife market.

9.9.6. Sispara day gecko (Cnemaspis sisparensis)

- It is a large gecko which dwells usually in forests, it is largely insectivorous and nocturnal.
- Habitat / distribution: Endemic to Western Ghats, and found in Sispara, Nilgiris, Kavalai near Cochin.
- Threats: Habitat conversion and modification.

Do you know?

The Protection of Plant Varieties and Farmers' Rights Act, 2001 while seeking to protect the rights of plant breeders, as mandated under TRIPS, has in an innovative fashion, managed to provide 'rights' to the Indian farmer.

9.10. FISH - CRITICALLY ENDANGERED

9.10.1. The Pondicherry Shark (Carcharhinus hemiodon)

- It is a marine fish that occurs or occurred inshore on continental and insular shelves.
- This is a very rare and little-known species.
- Habitat / distribution: Indian Ocean – from Gulf of Oman to Pakistan, India and possibly Sri Lanka.
- In scattered localities spanning India to New Guinea. Also been recorded at the mouth of the Hooghly river.
- Threats: Large, expanding, and unregulated commercial fisheries in inshore localities and habitats. If still extant, it is probably caught as bycatch, although market surveys have failed to record it. Its populations are considered to have been severely depleted as a result of continued exploitation.

9.10.2. The Ganges Shark (Glyphis gangeticus)

- It is a uniquely adapted fish-eating shark that occurs in the turbid waters of the Ganga river and the Bay of Bengal. The small eyes suggest that it is adapted to living in turbid water, while the slender teeth of the species suggests that it is primarily a fish-eater.
- Habitat / distribution: It occurs in India and possibly in Pakistan. The Ganga river system and Hooghly river mouth are its known habitats.
- Threats: Major fisheries targeting sharks. Other probable threats include overfishing, pollution, increasing river use and construction of dams and barrages. A few jaws of the species were found to have been traded in the international market during recent years, which testifies that the species is not extinct.

9.10.3. The Knife-tooth Sawfish (Anoxypristis cuspidata)

- It has a long narrow snout with blade-like teeth and a shark-like body. It spends most of its time near the bottom of the sea, sometimes going down to almost 40 m. It can grow up to 2.8 m. in length and can withstand a range of salinity conditions. It is found in shallow coastal waters and estuaries.
- Habitat / distribution: Widespread in western part of the Indo-Pacific region, including Red Sea.
- Threats: The principal threat to all sawfish are fisheries (targeted, by Wcatch, commercial and subsistence). Their long tooth-studded saw, makes them extraordinarily vulnerable to entanglement in any sort of net gear, including primitive fishing contraptions.
- When sawfish are caught in by catch, they often end up being traded because of the very high value of their products (meat is high quality and fins and saws extremely valuable in international trade).

9.10.4. Large-tooth Sawfish (Pristis microdon)

- They are heavy-bodied sawfish with a short but massive saw, and grow up to 3 m. in length. It is seen seasonally and very occasionally caught along with the Bull Sharks and the Green Sawfish.
- Habitat / distribution and habitat : Western part of the Indo-Pacific (East Africa to New Guinea, Philippines and Vietnam to Australia).
- In India, it is known to enter the Mahanadi river, up to 64 km inland, and also is very common in the estuaries of the Ganga and Brahmaputra.
- Threats: Same as that for the Knife-tooth Sawfish. There is also an increasing demand for sawfish in aquaria. Major habitat changes include construction of dams over rivers, siltation, pollution from industries and mining operations.

9.10.5. Long-comb Sawfish or Narrow-snout Sawfish (Pristis zijsron)

- It grow up to 4.3m in length and are heavily exploited by humans. This species was reported as frequently found in shallow water. It inhabits muddy bottoms and also enters estuaries. Its presence has been recorded in inshore marine waters, and it goes down to depths of at least 40 m.
- Habitat / distribution and habitat: Indo-Pacific region including Australia, Cambodia, China, India, Indonesia and Malaysia.
- Threats: This species has been damaged intensively, both as a target species and as incidental by catch in commercial, sport or shark-control net fisheries, as well as for aquarium display. As a result, it has become severely depleted in recent decades, and now appears to have been extirpated from many parts of its range.

Do you know?

Pugmark Census Technique: In this method the imprints of the pugmark (foot print) of the tiger were recorded and used as a basis for identification of individuals. Now it is largely used as one of the indices of tiger occurrence and relative abundance.

9.11. SPIDERS - CRITICALLY ENDANGERED

9.11.1. Rameshwaram Ornamental or Rameshwaram Parachute Spider (Poecilotheria hanumavilasumica)

- It was recently described in 2004, and is only found in India. It can give a nasty bite which usually is not fatal.
- The species is semi-social, which means they live partly in groups.
- Habitat: Arboreal and tend to live in hiding.
- Distribution: Endemic to India. Spread along the coastal savannah, tropical lowland rain forests and montane forests upto an altitude of 2000 m above mean sea level.
- Threats: Major threats causing the disappearance of this species is habitat alteration and degradation.

9.11.2. Gooty Tarantula, Metallic Tarantula or Peacock Tarantula (Poecilotheria metallica)

- Is steel blue in colour with patches of intense orange-yellow, black and white. It was first found in Gooty (Ooty/Udagamandalam) in south India in a burn pile during railway construction.
- Ever since the first picture of this spider was circulated globally, it has been in great demand in the illegal pet trade.
- A combination of small litter sizes and increased human pressures have made this species critically endangered.
- Habitat: Wooded mountain area.
- Distribution: Endemic to South India
- Threats: They are one of the most expensive spiders in the illegal pet trade. Large areas where the species occurs have been deforested, or subjected to habitat degradation due to local fuel wood collection, leading to decline in its population.

Do you know?

1. Roots store more starch than the trunk.
2. Roots do not have a central pith (soft central tissue) while the trunk does.
3. The majority of tree roots are non-woody. These non-woody roots only live for a few weeks.
4. The root hairs grow within days, when water, temperature, and nutrients are available to promote growth.

9.12. CORALS

9.12.1. Fire corals (Millepora boschmai)

- They are more closely related to jellyfish than corals. On contact, one usually feels a burning sensation similar to a sting from a jellyfish.
- The scientific name 'millepora' is derived from the several small pores on the surface of these corals. They are usually yellow green or brown in colour.
- Habitat: Millepora species are generally found in murky inshore waters and display a tolerance for siltation. They often are found in clear offshore sites.
- Distribution: Indonesia, Gulf of Chiriquí, Panama Pacific Province. Possibly extinct from Australia, India, Indonesia, Malaysia, Panama, Singapore and Thailand.
- Threats: Collected for decoration and jewellery trade. This group is also sensitive to temperature rise, and is thought to have completely disappeared from the majority of marine areas possibly because of growing global warming related bleaching effects.

9.13. BIRD'S MIGRATION

- Migration refers to the regular, recurrent and cyclical seasonal movement of birds from one place to other. The distance of migration ranged from short distance to thousands of kilometers. But at the end of period, birds will eventually return to the original place.

9.13.1. Reasons for migration

1. To avoid adverse factors (extreme climatic condition)
2. To manage food shortage
3. To manage shortage of water
4. To have a better breeding conditions
5. Less competition for safe nesting places

9.13.2. Migratory birds of India

Winter birds	Summer birds
Siberian Cranes, Greater Flamingo, Common Teal, Yellow Wagtail, White Wagtail, Northern Shoveler, Rosy Pelican, Wood Sandpiper, Spotted Sandpiper, Eurasian Pigeon, Black Tailed Godwit, Spotted Redshank Starling Bluethroat, Long Billed Pipit.	Asian Koel, Black Crowned Night Heron, Eurasian Golden Oriole, Comb Duck, Blue Cheeked Bee Eater, Blue-Tailed Bee-Eater, Cuckoos.

9.14. WILDLIFE DISEASES

Diseases	Casual organism	Animal susceptible
Tuberculosis	Mycobacterium spp	Deer, cat, primates, elephant
Anthrax	Bacillus anthraxis	Gaur, chetal, wild pig, barking deer
Rabies	Rabies virus	Tiger, lion, bear, mongoose, squirrel
Foot and mouth disease	FMD virus	Gaur, nilgai, chetal, sambar, yak, mithun
Rinder pest	Microbilli virus	Deer, wild pig, wild buffalo
Trypanosomia	Trypanosomia virus	Tiger, elephant, sambar, macaque
Taxoplasmosis	Taxoplasma gondii	Rhesus macaque, civet cat

9.15. SPECIES EXTINCTION

➢ Extinction is caused through various processes:

- Deterministic processes that have a cause and effect. E.g. glaciations, human interference such as deforestation.
- Stochastic processes (chance and random events) that effect the survival and reproduction of individuals. E.g. unexpected changes of weather patterns, decreased food supply, disease, increase of competitors, predators or parasites, etc. that may act independently or add to deterministic effects.

➢ The impact of these processes will of course depend on the size and degree of genetic diversity and resilience of populations.

➢ Traits that adversely affect or increase a species vulnerability to extinction due to habitat fragmentation have been identified. These are:

- rarity or low abundance
- poor dispersal ability
- ecological specialization
- unstable populations
- high trophic status – as animals occupying a higher trophic level (i.e. the position of a species in a food chain) usually have smaller populations than those at lower levels (e.g. carnivores are fewer in number than herbivores)
- low adult survival rates
- low intrinsic rate population increase
- Body size, fecundity, dietary specialization.

9.15.1. Natural extinctions

➢ Have been caused due to several factors:

- continent drifting,
- climate change,
- tectonic activity
- increased volcanic activity
- The late Ordovician global glaciations (439 Mya).
- The late Cretaceous extinction assumed to be associated with an extra-terrestrial impact.

➢ Extinction in vascular plants has been more gradual compared with the loss of animals. It is believed that extinction among this group was due more to competitive displacement by more advanced plant forms, or due to a gradual climate change, than due to any sudden catastrophic event.

9.15.2. Artificial Extinction

➢ Even though species extinction is a natural process which can happen without the intervention of humans, extinctions caused by humans is now happening over and above the reasonable estimate of natural extinction rates.

➢ Species are threatened with extinction by the intervention of humans due to:

- direct causes – such as hunting, collection or capture and persecution
- Indirect causes – such as habitat loss, modification and fragmentation and the introduction of invasive species.

9.16. MAN - ANIMAL CONFLICT

- It refers to the interaction between wild animals and people and the resultant negative impact on people or their resources, or wild animals or their habitat. It occurs when wildlife needs overlap with those of human populations, creating costs to residents and wild animals.

Causes

- Human population growth
- Land use transformation
- Species habitat loss, degradation and fragmentation
- Increasing livestock populations and competitive exclusion of wild herbivores
- Growing interest in ecotourism and increasing access to nature reserves
- Abundance and distribution of wild prey
- Increasing wildlife population as a result of conservation programmes
- Climatic factors
- Stochastic events (e.g. fire)

Impacts

- Crop damage
- Livestock depredation
- Injuries to people
- Loss of human life
- Damage to property
- Injuries to wildlife
- Animal deaths
- Destruction of habitat

Preventive strategies

- Artificial and natural barriers (physical and biological)
- Guarding
- Alternative high-cost livestock husbandry practices
- Relocation: voluntary human population resettlement
- Waste management systems that restrict wildlife access to refuse

Mitigative strategies

- Compensation systems
- Insurance programmes
- Incentive programmes
- Community based natural resource management schemes (CBNRMS)
- Regulated harvest
- Increase alternate crops, preys or water points
- Wildlife translocation
- Conservation education for local populations
- Better sharing of information.

◆◆◆◆◆◆

CHAPTER - 10

PLANT DIVERSITY OF INDIA

10.1. PLANT CLASSIFICATION

1. Herb is defined as a plant whose stem is always green and tender with height of not more than 1 meter.
2. Shrub is defined as a woody perennial plant differing from a perennial herb in its persistent and woody stem. It differs from a tree in its low stature and its habit of branching from the base. Not more than 6 meters in height.
3. Tree is defined as a large woody perennial plant having a single well defined stem with more or less definite crown.
4. Parasites - An organism that draws a part or whole of its nourishment from another living organism. These plants do not draw moisture and mineral nutrients from the soil. They grow on some living plant called host and penetrate their sucking roots, called haustoria, into the host plants.
    - Total parasite - draws whole of its nourishment
    - Partial parasite - draws a part of its nourishment
5. Epiphytes - plant growing on the host plant but not nourished by the host plant. They do not draw food from the host plant. They only take the help of the host plant in getting access to light. Their roots perform two functions. While changing roots establish the plant on the branches of the host plant, aerial roots draw moisture from the air. Eg. Vanda
6. Climbers - herbaceous or woody plant that climbs up trees or other support by twining round them or by holding on to them by trendrills, hooks, aerial roots or other attachments.

Do you know?

Bats are MAMMALS. They are warm blooded, nurse their babies with milk and have fur. Bats are only mammals that can fly (without an airplane!)

10.2. EFFECT OF ABIOTIC COMPONENTS ON PLANTS

10.2.1. Intensity of light on growth of plants

- Extremely high intensity favours root growth than shoot growth which results in increased transpiration, short stem, smaller thicker leaves. On the other hand low intensity of light retards growth, flowering and fruiting.
- When the Intensity of light is less than the minimum, the plants ceases to grow due to accumulation of $CO2$ and finally dies.
- Out of 7 colours in the visible part of spectrum, only red and blue are effective in photosynthesis.
- Plant grown in blue light are small, red light results in elongation of cells results in etiolated plants. Plants grown in ultraviolet and violet light are dwarf.

10.2.2. Effect of frost on plants

- Killing of young plants - Even a light radiation frost chills the soil resulting in freezing the soil moisture. The plants growing in such soil, get exposed to direct sun light in the morning, they are killed due to increased transpiration when their roots are unable to supply moisture. This is the main reason for innumerable death of sal seedlings.
- Death of plants due to damage to cells - As a result of frost, water in the intercellular spaces of the plant gets frozen into ice which withdraws water from the interior of the cells. This results in increasing concentration of salts and dehydration of cells. Thus coagulation and precipitation of the cell colloid results in death of plant.
- Leads to Formation of canker.

Do you know?

The male frog will hug the female from behind and as she lays eggs, usually in the water, the male will fertilize them. After that the eggs are on their own, to survive and become tadpoles. There are a few species of frogs that will look after their babies, but not many.

10.2.3. Effects of Snow on plants

- Snow influences the distribution of deodar, fir and spruce.
- Snow acts as blanket, prevents further drop in temperature and protects seedlings from excessive cold and frost.
- It results in mechanical bending of tree stem.
- Shortens the period of vegetative growth also uproots the trees.

10.2.4. Effect of temperature on plants

- Excessive high temperature results in death of plant due to coagulation of protoplasmic proteins. It disturbs the balance between respiration and photo synthesis thereby causes depletion of food resulting in greater susceptibility to fungal and bacterial attack.
- It also results in desiccation of plant tissues and depletion of moisture.

10.2.5. Die back

Refers the progressive dying usually backwards from the tip of any portion of plant. This is one of the adaptive mechanisms to avoid adverse conditions. In this mechanism, the root remains alive for years together but the shoots dies. Eg. Sal, Red sanders, Terminalia tomentosa, Silk cotton tree, Boswellia serrata.

Causes for die back

1. Dense over head canopy and inadequate light
2. Dense week growth
3. Un-decomposed leaf litter on surface
4. Frost
5. Drip
6. Drought
7. Grazing

Do you know?

Elephants have remarkable memories. In the wild, they appear to remember for years the relationships with dozens, perhaps hundreds of other elephants, some of whom they may see only occasionally. They also have an impressive memory for places to drink and to find food. This information gets passed on from generation to generation.

Males elephants do not maintain long-term social bonds, remaining in the unit only into their teens. They then live out their lives in loose bachelor groups or wandering on their own.

10.3. INSECTIVOROUS PLANTS

These plants are specialised in trapping insects and are popularly known as insectivorous plants.

They are very different from normal plants in their mode of nutrition. They, however, never prey upon humans or large animals as often depicted in fiction.

Insectivorous plants can broadly be divided into active and passive types based on their method of trapping their prey.

- The active ones can close their leaf traps the moment insects land on them.
- The passive plants have a 'pitfall' mechanism, having some kind of jar or pitcher-like structure into which the insect slips and falls, to eventually be digested.

The insectivorous plants often have several attractions such as brilliant colours, sweet secretions and other curios to lure their innocent victims.

Why do they hunt despite having normal roots and photosynthetic leaves?

These plants are usually associated with rain-washed, nutrient-poor soils, or wet and acidic areas that are ill-drained. Such wetlands are acidic due to anaerobic conditions, which cause partial decomposition of organic matter releasing acidic compounds into the surroundings. As a result, most microorganisms necessary for complete decomposition of organic matter cannot survive in such poorly oxygenated conditions.

Normal plants find it difficult to survive in such nutrient poor habitats. The hunter plants are successful in such places because they supplement their photosynthetic food production by trapping insects and digesting their nitrogen rich bodies.

10.3.1. The Indian Hunters

Insectivorous plants of India belong mainly to three families:

1. Droseraceae (3 species),
2. Nepenthaceae (1 species)and
3. Lentibulariaceae (36 species).

1. **Family: Droseraceae:**

- This includes 4 genera of which 2, namely Drosera and Aldrovanda, occur in India.

(a) **Drosera or Sundew** inhabiting wet infertile soils or marshy places

- Insect trapping mechanism: The tentacles on the leaves secrete a sticky fluid that shines in the sun like dew-drops. Therefore the Drosera spp. are commonly known as 'sundews'. When an insect lured by these glistening drops alights on the leaf surface it gets stuck in this fluid and are absorbed and digested.

(b) Aldrovanda is a freefloating, rootless aquatic plant, the only species found in India, occurs in the salt marshes of Sunderbans, south of Calcutta. It also grows in fresh water bodies like ponds, tanks and lakes.

- **Insect trapping mechanism:** On the leaf midrib are found some sensitive trigger hairs. The two halves of the leaf blade of Aldrovanda close along the midrib the moment an insect comes into contact with the leaf, trapping the victim inside.

2. Family Nepenthaceae:

- It consists of a single genus Nepenthes having about 70 species distributed throughout the tropical Old World. The members of the family are commonly known as 'pitcher plants' because their leaves bear jar-like structures.
- Distribution - It is confined to the high rainfall hills and plateaus of north-eastern region, at altitudes ranging from 100 – 1500 m, particularly in Garo, Khasi and Jaintia hills of Meghalaya.
- Insect trapping mechanism: Nepenthes conforms to the pitfall type of trap. A honey like substance is secreted from glands at the entrance of the pitcher. Once the insect enters into the pitcher, it falls down because of the slipperiness.
- The inner wall, towards its lower half, bears numerous glands, which secrete a proteolytic enzyme. This enzyme digests the body of the trapped insects and nutrients are absorbed.

3. Family: Lentibulariaceae:

- It have 4 genera, of which Utricularia and Pinguicula, occur in India.

(a) **Utricularia or Bladderworts :** The Bladderworts generally inhabit freshwater wetlands and waterlogged areas. Some species are associated with moist moss covered rock surfaces, and damp soils during rains.

- Insect trapping: Utricularia in its bladders mouth, has sensitive bristles or hairs. When an insect happens to contact these hairs the door opens, carrying the insect into the bladder along with a little current of water. The door is shut when water fills the bladder, The enzymes produced by the inner wall of the bladder digest the insect.

(b) **Pinguicula or Butterwort:** It grows in the alpine heights of Himalayas, from Kashmir to Sikkim, along stream-sides in cool boggy places.

- Insect trapping mechanism: In Pinguicula, an entire leaf works as trap. When an insect lands on the leaf surface, it gets stuck in the sticky exudate. the leaf margins roll up thus trapping the victim.

Medicinal properties

Drosera are capable of curdling milk, its bruised leaves are applied on blisters, used for dyeing silk.

Nepenthes in local medicine to treat cholera patients, the liquid inside the pitcher is useful for urinary troubles, it is also used as eye drops.

Utricularia is useful against cough, for dressing of wounds, as a remedy for urinary disease.

10.3.2. Conservation level

In India, species like Drosera peltata, Aldrovanda vesiculosa and Nepenthes khasiana have been included in the Red Data Book as endangered plants.

10.3.4. Threat

- Gardening trading for medicinal properties is one of the main causes for their decline.
- Habitat destruction is also rampant, the wetlands harbouring such plants being the main casualties during the expansion of urban and rural habitation.
- Pollution caused by effluents containing detergents, fertilizers, pesticides, sewage etc into the wetlands is yet another major cause for their decline (Since insectivorous plants do not tolerate high nutrient levels)
- Moreover, polluted water bodies are dominated by prolific water weeds which cause elimination of the delicate insectivorous plants.

Do you know?

Tiger, delineates its own territory by urinating on the trees and rocks along the boundary and lives within that. Trespass by another male usually ends up in conflict which turns into a bloody battle sometimes. The tigresses in a family may have overlapping territories within the male's territory.

Even though tiger is a powerful predator with plenty of tactics, it is observed that only one in twenty attempts of hunting is really successful.

10.4. INVASIVE ALIEN SPECIES

Purposely or accidentally, people often bring non-native species into new areas where the species have few or no natural predators to keep their populations in check.

Aliens are species that occur outside their natural range. Alien species that threaten native plants and animals or other aspects of biodiversity are called alien invasive species. They occur in all groups of plants and animals, as competitors, predators, pathogens and parasites, and they have invaded almost every type of native ecosystem,

Biological invasion by alien species is recognised as one of the major threats to native species and ecosystems. The effects on biodiversity are enormous and often irreversible.

10.4.1. Invasion and Species Richness?

The invasions potentially lead to an increase in species richness, as invasive species are added to the existing species pool. But it also leads to extinction of native species, resulting in decrease of species richness. The negative interactions are primarily the competition with natives for food and sustenance, which may not allow coexistence and also by predation.

10.4.2. Effects

- Loss of Biodiversity
- Decline of Native Species (Endemics).
- Habitat Loss
- Introduced pathogens reduce crop and stock yields
- Degradation of marine and freshwater ecosystems

This biological invasion constitutes the greatest threat to biodiversity, and it has already had devastating consequences for the planet and challenges for the conservation managers.

About 235 invasive alien species (both flora and fauna) are reported in India by Global Invasive Alien Species Database.

Are black rhinos really black?

No, black rhinos are not black at all. The species probably derives its name as a distinction from the white rhino (which is not white at all either) or from the dark-colored local soil that often covers its skin after wallowing in mud.

10.4.3. Some Invasive fauna in India are:

1. A new invasive gall forming insect of Eucalyptus in Southern India.
   - Leptocybe invasa a new insect pest detected from few pockets of coastal Tamil Nadu and it has spread to peninsular India
   - It is a tiny wasp that forms leaf and stem galls in Eucalyptus.
2. Crazy ant
3. Giant African snail
4. Myna
5. Gold Fish
6. Pigeon
7. Donkey
8. House Gecko
9. Tilapia

Do you know?

Leopard and Panther are one and the same and its zoological name is Panthera pardus.

10.5. SOME INVASIVE ALIEN FLORA OF INDIA

10.5.1. Needle Bush

- Nativity: Trop. South America
- Distribution in India: Throughout
- A shrub or small tree.
- Remarks: Occasional in thorny scrub and dry degraded forests and often creates close thickets.

10.5.2. Black Wattle

- Nativity: South East Australia
- Distribution in India: Western Ghats
- Remarks: Introduced for afforestation in Western Ghats. Regenerates rapidly after fire and forms dense thickets. It is distributed in forests and grazing lands in high altitude areas.

10.5.3. Goat weed

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Troublesome weed in gardens, cultivated fields and forests.

10.5.4. Alternanthera paronychioides

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Occasional weed along edges of tanks, ditches and in marshy lands.

10.5.5. Prickly Poppy

- Nativity: Trop. Central & South America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common winter season weed in cultivated fields, scrub lands and fringes of forests.

10.5.6. Blumea eriantha

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Abundant along railway tracks, road sides and degraded forest lands.

10.5.7. Palmyra, Toddy Palm

- Nativity: Trop. Africa
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Cultivated and self sown, occasionally found to be gregarious near by cultivated fields, scrub lands and waste lands.

10.5.8. Calotropis / Madar, Swallo Wort

- Nativity: Trop. Africa
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common in cultivated fields, scrub lands and waste lands.

10.5.9. Datura, Mad Plant, Thorn Apple

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Occasional weed on disturbed ground.

10.5.10. Water Hyacinth

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Abundant in still or slow floating waters. Nuisance for aquatic ecosystems.

10.5.11. Impatiens, Balsam

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common along streams of moist forests and occasionally along railway tracks; also runs wild in gardens.

Do you know?

Sea cow, Dugong dugon occurs in near shore waters of Gulf of Mannar, Gulf of Kachchh and Andaman and Nicobar Islands.

10.5.12. Ipomoea / the pink morning glory

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common weed of marhsy lands and along the edges of tanks and ditches.

10.5.13. Lantana camara / Lantana, Wild Sage

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common weed of forests, plantations, habitation, waste lands and scrub lands.

10.5.14. Black Mimosa

- Nativity: Trop. North America
- Distribution in India: Himalaya, Western Ghats
- Remarks: Aggressive colonizer. It invades water courses and seasonally flooded wetlands.

10.5.15. Touch-Me-Not, Sleeping Grass

- Nativity: Brazil
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common weed of cultivated fields, scrub lands and degraded forests.

10.5.16. 4 '0' clock plant.

- Nativity: Peru
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Runs wild in gardens and near habitation.

10.5.17. Parthenium / Congress grass, Parthenium

- Nativity: Trop. North America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common weed of cultivated fields, forests, overgrazed pastures, waste lands and gardens.

10.5.18. Prosopis juliflora / Mesquite

- Mesquite
- Nativity: Mexico
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common weed of waste lands, scrub lands and degraded forests.

10.5.19. Townsend grass

- Nativity: Trop. W. Asia
- Distribution in India: Throughout
- Remarks: Very common along streams and banks of rivers.

10.6. MEDICINAL PLANTS

10.6.1. Beddomes Cycad / Perita / Kondaitha

- Eastern Peninsular India.
- Uses : The male cones of the plant are used by local herbalists as a cure for rheumatoid arthritis and muscle pains. Fire resistant property is also there.

10.6.2. Blue vanda / Autumn Ladies Tresses Orchid

- Distribution : Assam, Arunachal Pradesh, Manipur, Meghalaya, Nagaland.
- Vanda is one of the few botanical orchids with blue flowers a property much appreciated for producing interspecific and intergeneric hybrids.

10.6.3. Kuth / Kustha / Pooshkarmoola / Uplet

- Distribution : Kashmir, Himachal Pradesh
- Uses : It is used as an anti-inflammatory drug, and a component of the traditional Tibetan medicine. The roots of the plant are used in perfumery. Dry roots (Kuth, Costus) are strongly scented and yields an aromatic oil, which is also used in making insecticides. The roots contain an alkaloid, 'saussurine', which is medicinally important.

10.6.4. Ladies Slipper Orchid

- Uses : These types of orchids are mainly used as collector's items but lady's slipper is some times used today either alone or as a component of formulas intended to produce treat anxiety / insomnia (scientific evidence is not present). This is also sometimes used topically as a poultice or plaster for relief of muscular pain.

10.6.5. Red vanda

- Distribution : Manipur, Assam, Andhrapradesh
- Uses : As a whole orchids are collected to satisfy an ever demanding market of orchid fanciers, especially in Europe, North America and Asia.

10.6.6. Sarpagandha

- Distribution : Sub Himalayan tract from Punjab eastwards to Nepal, Sikkim, Assam, Eastern & Western Ghats, parts of Central India & in the Andamans.
- Uses : Rauvolfia roots are of immense medicinal value and has steady demand. It is used for treating various central nervous system disorders. The pharmacological activity of rauvolfia is due to the presence of several alkaloids of which reserpine is the most important, which is used for its sedative action in mild anxiety states and chronic psychoses. It has a depressant action on central nervous system produces sedation and lower blood pressure. The root extracts are used for treating intestinal disorders, particularly diarrhoea and dysentery and also anthelmintic. It is used for the treatment of cholera, colic and fever. The juice of the leaves are used as a remedy for opacity of the cornea. The total root extracts exhibits a variety of effects, viz., sedation, hypertension, brodyeardia, myosis, ptosis, tremors, which are typical of reserpine.

Do you know?

India hosts the Eleventh meeting of the Conference of the Parties (CoP-11) to the Convention on Biological Diversity (CBD), from 8- 19 October 2012 in Hyderabad, India.

CBD COP 11 assumes immense importance as it was held in the 40th anniversary year of Stockholm Conference held in 1972, 20th anniversary year of Rio Earth Summit held in 1992, and 10th anniversary year of World Sustainable Summit held in 2002. This is also the first CoP in the UN Decade on Biodiversity 2011-2020.

10.6.7. Ceropegia species.

- Lantern Flower, Parasol Flower, Parachute Flower, Bushman's Pipe.
- Uses : These plants are used as ornamental plants.

10.6.8. Emodi / Indian Podophyllum

- Himalayan May Apple, India May Apple etc.,
- Distribution : Lower elevations in and around surrounding the Himalayas.
- Uses : Rhizomes and roots constitute the drug. The dried rhizome form the source of medicinal resin. Podophyllin is toxic and strongly irritant to skin and mucous membranes.

10.6.9. Tree Ferns

- Distribution : Lower elevations in and surrounding the Himalaya.
- Uses : The Soft Tree Fern can be used as a food source, with the pith of the plant being eaten either cooked or raw. It is a good source of starch.

10.6.10.Cycads

- A Gymnosperm tree.
- All known as living fossil.
- Distribution: Western ghats, Eastern ghats, North East India and Andaman and Nicobar Islands.
- Cycads have been used as a source of starch and also during socio-cultural rituals.
- There is some indication that the regular consumption of starch derived from cycads is a factor in the development of Lytico-Bodig disease, a neurological disease with symptoms similar to those of Parkinson's disease and ALS.
- Threats : Over harvesting, Deforestation and forest fire.

10.6.11.Elephant's foot

- Distribution : Throughout the North Western Himalayas.
- Uses : Commercial source of Diosgenin (a steroid sapogenin, is the product of sapogenin, is the product of hydrolysis by acids, strong bases, or enzymes of saponins, extracted from the tubers of Dioscorea wild yam. The sugar-free (aglycone), diosgenin is used for the commercial synthesis of cortisone, pregnenolone, progesterone, and other steroid products).

Do you know?

Sharks give birth to pups in three ways

I. eggs are laid (like birds)

II. eggs hatch inside the mother and then are born

III. pups (sharks) grow inside the mother.

10.7. TREE CHARACTERS

10.7.1. Types of Trees:

There are two main types of trees: deciduous and evergreen.

(i) Deciduous trees

- lose all their leaves for part of the year.
- In cold climates, this happens during the autumn so that the trees are bare throughout the winter.
- In hot and dry climates, deciduous trees usually lose their leaves during the dry season.

(ii) Evergreen trees

- don't lose all their leaves at the any time (they always have some foliage).
- They do lose their old leaves a little at a time with new ones growing in to replace the old. An evergreen tree is never completely without leaves.

Do you know?

The world's oldest trees are 4,600 year old Bristlecone pines in U.S.A.

10.7.2. Parts of a Tree:

Roots:

- The roots are the part of the tree that grows underground.
- Besides keeping the tree from tipping over, the main job of the roots is to collect water and nutrients from the soil and to store them for times when there isn't as much available.

Crown:

- The crown is made up of the leaves and branches at the top of a tree.
- The crown shades the roots, collects energy from the sun (photosynthesis) and allows the tree to remove extra water to keep it cool (transpiration -- similar to sweating in animals).

Leaves:

- They are the part of the tree that converts energy into food (sugar).
- Leaves are the food factories of a tree.
- They contain a very special substance called chlorophyll. It is chlorophyll that gives leaves their green colour.
- Chlorophyll is an extremely important biomolecule, used in photosynthesis. leaves use the sun's energy to convert carbon dioxide from the atmosphere and water from the soil into sugar and oxygen.
- The sugar, which is the tree's food, is either used or stored in the branches, trunk and roots. The oxygen is released back into the atmosphere.

Branches:

- The branches provide the support to distribute the leaves efficiently for the type of tree and the environment.

- They also serve as conduits for water and nutrients and as storage for extra sugar.

Do you know?

1. Trees are the largest and oldest living organism on earth.
2. It can take 10 minutes to walk around the crown of a giant banyan tree in Calcutta.
3. Trees trap more of the sun's energy than any other group of organisms on earth
4. Trees do not restore and repair wood that is injured and infected, instead they compartmentalize off the damaged tissue.

Trunk:

- The trunk of the tree provides its shape and support and holds up the crown.
- The trunk transports water and nutrients from the soil and sugar from the leaves.

10.7.3. Parts of the Trunk:

Annual rings

- Inside the trunk of a tree there are a number of growth rings.
- Each year of the tree's life, a new ring is added so it is referred as the annual rings.
- It is used to calculate Dendro-Chronology (Age of a tree) and Paleo-Climatology.
- The age of a tree can be determined by the number of growth rings. The size of the growth ring is determined in part by environmental conditions - temperature, water availability.

Bark:

- The outside layer of the trunk, branches and twigs of trees.
- The bark serves as a protective layer of the tree.
- Trees actually have inner bark and outer bark. The inner layer of bark is made up of living cells and the outer layer is made of dead cells, sort of like our fingernails.
- The scientific name for the inner layer of bark is Phloem. The main job of this inner layer is to carry sap full of sugar from the leaves to the rest of the tree.
- A number of handy things are made from bark including latex, cinnamon and some kinds of poisons. It isn't surprising the strong flavours, scents and toxins can often be found in the bark of different types of trees.

Cambium:

- The thin layer of living cells just inside the bark is called cambium.
- It is the part of the tree that makes new cells allowing the tree to grow wider each year.

Sapwood (Xylem):

- The scientific name for sapwood is xylem.
- It is made up of a network of living cells that bring water and nutrients up from the roots to the branches, twigs and leaves.
- It is the youngest wood of the tree -- over the years, the inner layers of sapwood die and become heartwood.

Heartwood:

- The heartwood is dead sapwood in the center of the trunk.
- It is the hardest wood of the tree giving it support and strength.
- It is usually darker in colour than the sapwood.

Pith:

- Pith is the tiny dark spot of spongy living cells right in the center of the tree trunk.
- Essential nutrients are carried up through the pith.
- It's placement right in the center means it is the most protected from damage by insects, the wind or animals

10.7.4. Root types

- Taproot - Primary descending root formed by the direct prolongation of the radicle of the embryo.
- Lateral Root - Roots that arise from the tap root and spread laterally to support the tree.
- Adventitious Roots - Roots that are produced from the parts of the plant other than the radicle or its subdivision. The following kinds of Adventitious Roots are commonly found in trees.
- Buttresses - They are out - growths formed usually vertically above the lateral roots and thus connect the base of the stem with roots. They are formed in the basal portion of the stem.
    - Ex : Silk cotton tree.
- Prop - Roots - Adventitious Roots - produced from the branches of the tree which remain suspended in the air till they reach the ground. On reaching the ground they enter into the soil and get fixed.
    - Ex : Banyan Tree

- Stilt - Roots - Adventitious Roots which emerged from the butt of a tree above ground level. So that the tree appears as if supported on flying buttresses.
  - Ex : Rhizphora species of mangroves.
- Pneumatophore : It is a spike like projection of the roots of swamp / mangrove tree above the ground. It helps the submerged roots to obtain oxygen.
  - Ex : Heretiera spp, Bruguiera spp.
- Haustorial roots are the roots of parasitic plants that can absorb water and nutrients from another plant.
  - Eg : mistletoe (Viscum alubum) and dodder.
- Storage roots are modified roots for storage of food or water, such as carrots and beets. They include some taproots and tuberous roots.
- Mycorrhiza - structure produced from the combination of the modified rootlet with fungal tissue.

Do you know?

1. A tree can absorb as much as 48 pounds of carbon dioxide per year and can sequester 1 ton of carbon dioxide by the time it reaches 40 years old.
2. Tree wood is a highly organized arrangement of living, dying, and dead cells.

10.7.5. Canopy classification–

- Relative completeness of canopy. Classified into 4 types.
  - Closed - the density is 1.0
  - Dense - the density is 0.75 to 1.0
  - Thin - the density is 0.50 to 0.75
  - Open - the density is under 0.50

10.7.6. Other characters

- Phenology - Science that deals with the time of appearance of characteristic periodic events such as leaf shedding etc.
- Etiolation - With the absence of adequate light, plants become pale yellow and have long thin internodes.
- Autumn tints - in some trees, leaves undergo a striking change in colour before falling from the tree.
  - Ex : Mango, Cassia fistula, Quercus incana
- Taper - the decrease in diametre of the stem of a tree from the base upwards. i.e., the stem is thicker at the base and thinner in the upper portion of the tree.
- Tapering occurs due to the pressure of the wind which is centred in the lower one third of the crown and is conveyed to the lower parts of the stem, increasing with increasing length. To counteract this pressure, which may snap the tree at the base, the tree reinforces itself towards the base.
- They are generally associated with the absence of long taproot system due to either shallow soil are badly aerated and infertile subsoil.
- Bamboo gregarious flowering - general flowering over the considerable area of all (or) most of the individuals of certain species, that do not flower annually. Generally followed by death of a plant.
- Sal Tree grows in variety of geological formations but completely absent in Deccan trap where its place is taken by teak.
- Sandal tree is a partial-root parasite. The seedlings of this species grow independently in the beginning but in few months develop haustorial connections with the roots of some shrub and later with some tree species growing in the vicinity. Sandle tree manufactures its own food but depends upon the host like other partial parasites for water and mineral nutrients.
- Aerial seeding is the process of dispersing the seed aerially. In India, aerial seeding has been done on experiment basis in Chambal ravines in UP, Rajasthan, West Bengal and Western Ghats of Maharashtra. The research carried out during 1982 shows that the survival percentage was 97.3 and 2.7 for Prosopis juliflora and Acacia nilotica respectively. The survey indicated that 25% of the area has not responded for aerial seeding at all.

◆ ◆ ◆

CHAPTER - 11

MARINE ORGANISMS

11.1. PLANKTON

- This group includes both microscopic plants like algae (phytoplankton) and animals like crustaceans and protozoans (zooplankton) found in all aquatic ecosystems, except certain swift moving waters.
- The locomotory power of the planktons is limited so that their distribution is controlled, largely, by currents in the aquatic ecosystems.
- Based on the length of life cycle / planktonic mode of life, they are grouped as:

1. Holoplankton (or) Permanent plankton: These organisms that are planktonic for their entire life cycle. Examples: radiolarians, foraminiferans, amphipods, krills, copepods, salps, and jellyfishes (except porifera, bryozoa, phoronida, prochordata and mammalia).
2. Meroplankton (or) Temporary plankton: These organisms that are planktonic for only a part of their life cycle, usually the egg and larval stages. Examples: the larvae of echinoderms, crustaceans, marine worms, and most fish.
    - After a period of time in the plankton, meroplankton either graduates to the nekton or adopt a benthic (often sessile) lifestyle on the seafloor.
    - While the former ones are distributed throughout the year, the latter forms are only seasonal in occurrence and are generally found distributed in shallow-neritic waters and in mangroves. The growth rate, productivity and species diversity of plankton in tropical waters especially in mangrove waters are high. The zooplankton community is represented by heterogeneous groups of organisms of varying size and belonging to different phyla of animal kingdom.

11.2. PHYTOPLANKTON

- The term 'plankton' refers to the group of organisms which float in the surface waters of the rivers, lakes and oceans.
- Derived from the Greek words phyto (plant) and plankton (made to wander or drift), phytoplankton are microscopic plant organisms that live in aquatic environments, both salty and fresh.
- Some phytoplankton are bacteria, some are protists, and most are single-celled plants. Among the common kinds are cyanobacteria, silica-encased diatoms, dinoflagellates, green algae, and chalk-coated coccolithophores.
- Like land plants, phytoplankton have chlorophyll to capture sunlight, and they use photosynthesis to turn it into chemical energy. They consume carbon dioxide, and release oxygen. All phytoplankton photosynthesize, but some get additional energy by consuming other organisms.
- These micro-algae are present throughout the lighted regions of all the seas and oceans including the Polar Regions.
- Their total biomass is many times greater than that of the total plants on land and they serve as the "pasture grounds" in the aquatic environment.
- Based on their size, phytoplankton can be classified as

1. macroplankton (more than 1 mm),
2. microplankton (less than 1 mm, retained by nets of mesh size 0.06 mm),
3. nanoplankton (between 5 and 60 micrometers) and
4. ultraplankton (less than 5 micrometers).

Do you know?

Sea Kraits are one of the few sea snakes that go to land to lay their eggs while most others, like the Olive sea snake will give birth in the water.

- Many phytoplankton species belong mainly to the nanoplankton and microplankton fractions.

11.2.1. Factors Affecting Phytoplanktons Biodiversity

Light

- Phytoplanktons are limited to the uppermost layers of the ocean where light intensity is sufficient for photosynthesis to occur.
- For most phytoplankton, the photosynthetic rate varies with light intensity.

Nutrients

- The major inorganic nutrients required by phytoplankton for growth and reproduction are nitrogen and phosphorus.
- Diatoms and silicoflagellates also require silicate (SiO2) in significant amounts.
- Some phytoplankton can fix nitrogen and can grow in areas where nitrate concentrations are low.
- They also require trace amounts of iron which limits phytoplankton growth in large areas of the ocean because iron concentrations are very low.
- Other inorganic and organic nutrients may be required is small amounts.
- All of those nutrients are the limiting factors for phytoplankton productivity under most conditions.

Temperature

- Temperature acts along with other factors in influencing the variation of photosynthetic production.
- Generally, the rate of photosynthesis increases with an increase in temperature, but diminishes sharply after a point is reached.
- Temperature, together with illumination, influences the seasonal variation of phytoplankton production in the temperate latitudes.

Salinity

- Besides light and temperature, salinity also is known to influence primary production.
- Many species of dinoflagellates reproduce actively at lower salinities.

Grazing by Zooplankton

- The grazing rate of zooplankton is one of the major factors influencing the size of the standing crop of phytoplankton, and thereby the rate of production.

Distribution

- Marine phytoplankton are not uniformly distributed throughout the oceans of the world. The highest concentrations are found at high latitudes, with the exception of upwelling areas on the continental shelves, while the tropics and subtropics have 10 to 100 times lower concentrations.
- In addition to nutrients, temperature, salinity and light availability; the high levels of exposure to solar UV-B radiation that normally occur within the tropics and subtropics may play a role in phytoplankton distributions.
- Phytoplankton productivity is limited to the euphotic zone, the upper layer of the water column in which there is sufficient sunlight to support net productivity.
- The position of the organisms in the euphotic zone is influenced by the action of wind and waves.

11.2.2. Importance of phytoplankton

The food web

- Phytoplanktons are the foundation of the aquatic food web, the primary producers, feeding everything from microscopic animal-like zooplankton to whales. Small fish and invertebrates also graze on the phytoplkanktons, and then those smaller animals are eaten by bigger ones.
- Phytoplankton can also be the harbingers of death or disease. Certain species of phytoplankton produce powerful biotoxins, making them responsible for so-called "red tides," or harmful algal blooms. These toxic blooms can kill marine life and people who eat contaminated seafood.
- Phytoplankton cause mass mortality in other ways. In the aftermath of a massive bloom, dead phytoplankton sink to the ocean or lake floor. The bacteria that decompose the phytoplankton deplete the oxygen in the water, suffocating animal life; the result is a dead zone.

Do you know?

Sea snakes are usually found in shallow waters of the Indian Ocean, and warmer areas of the Pacific Ocean. They eat fish, fish eggs and eels.

11.2.3. Phytoplankton - the Carbon Cycle and climate change

- Through photosynthesis, phytoplanktons consume carbon dioxide on a scale equivalent to forests and other land plants. Some of this carbon is carried to the deep ocean when phytoplankton die, and some is transferred to different layers of the ocean as phytoplankton are eaten by other creatures, which themselves reproduce, generate waste, and die.
- Worldwide, this "biological carbon pump" transfers about 10 gigatonnes of carbon from the atmosphere to the deep ocean each year. Even small changes in the growth of phytoplankton may affect atmospheric carbon dioxide concentrations, which would feed back to global surface temperatures.
- Phytoplankton are responsible for most of the transfer of carbon dioxide from the atmosphere to the ocean. Carbon dioxide is consumed during photosynthesis, and the carbon is incorporated in the phytoplankton, just as carbon is stored in the wood and leaves of a tree. Most of the carbon is returned to near-surface waters when phytoplankton are eaten or decompose, but some falls into the ocean depths.

Do you know?

1. Sharks have a sensory organ called the "ampullae of Lorenzini" which they use to "feel" the electrical field coming from its prey.
2. Silverfish is an insect that can be found in old unused books

11.3. ZOOPLANKTON

- Zooplankton play vital role in food web of the food chain, nutrient recycling, and in transfer of organic matter from primary producers to secondary consumers like fishes.
- They are more abundant within mangrove water-ways than in adjacent coastal waters, and a large proportion of the juvenile fish of mangrove habitat are zooplanktivorous.
- The zooplankton determine the quantum of fish stock. Hence, zooplankton communities, based on their quality and species diversity, are used for assessing the productivity vis-à- vis fishery resource, fertility and health status of the ecosystem.
- Marine zooplankton comprises a large variety of different organisms, their sizes range from tiny flagellates (a few mm large) to giant jellyfish (2 m diameter) for the operational point of view and for the sake of convenience, the planktons are generally categorized as nanoplankton (<20 μm) and net plankton (>50 μm).

11.4. SEA-GRASS

- Sea grasses are specialised angiosperms (marine flowering plants) that resemble grass in appearance.
- They produce flowers; have strap-like or oval leaves and a root system.
- They grow in shallow coastal waters with sandy or muddy bottoms & require comparatively calm areas.
- They are the only group of higher plants adapted to life in the salt water.
- Major Sea grass meadows in India occur along the south east coast of Tamil Nadu and in the lagoons of a few Lakshadweep Islands. There are few grass beds around Andaman and Nicobar islands also.
- The rich growth of seagrasses along the Tamil Nadu coast and Lakshadweep islands is mainly due to high salinity, clarity of the water and sandy substratum.

11.4.1. Functions

1. Sea grass beds physically help
   - to reduce wave and current energy,
   - to filter suspended sediments from the water and
   - stabilise bottom sediments to control erosion.
2. Provides habitat for marine invertebrates and fishes.
3. Seagrass beds are widespread in lagoon & in such areas, the population of fish and migratory birds are also higher due to the availability of food and shelter.
4. Sea grasses on reef flats and near estuaries are also nutrient sinks, buffering or filtering nutrient and chemical inputs to the marine environment.

Do you know?

The five species of turtle that nest on Indian coast are Leatherback sea turtle, Green turtle, the Olive Ridley, the Hawksbill, and the Loggerhead turtle.

- IUCN has accorded high priority for the conservation of sea grass.
- Out of 58 species found in the world, Fourteen species of seagrasses have been recorded from Indian coast.
- They are commonly distributed from inter-tidal to sub-tidal region down to 8 m depth.
- Dugong, a mammal dependent on sea grass for food, is also on the verge of extinction.

11.4.2. Threats to sea grass beds

- Eutrophication, siltation, trawling, coastal engineering constructions and over exploitation for commercial purposes are the major threats for sea grass beds.

11.4.3. Policy lacunae

- Sea grass occurs in shallow water bodies and since water bodies are not brought under regulations, the CRZ notification is ineffective to protect sea grass beds as the seagrass beds are below the Low Tide Line.

11.4.4. Management

- The major seagrass beds should be mapped and areas has to be identified for preservation.
- Dredging should be carried out far away from seagrass beds as siltation /turbidity destroys seagrass beds.

11.5. SEAWEEDS

- Seaweeds are (thalloid plants) macroscopic algae, which mean they have no differentiation of true tissues such as roots, stems and leaves. They have leaf-like appendages.
- Seaweeds, the larger and visible marine plants are found attached to rocks, corals and other submerged strata in the intertidal and shallow sub tidal zones of the sea.
- Seaweeds grow in shallow coastal waters wherever sizable substata is available.
- Based on the colour of their pigmentation, sea weeds are broadly classified into different classes such as
  - blue- green,
  - green,
  - brown,
  - red etc.

11.5.1. Functions of seaweeds

- Food for marine organism,
- habitat for fish breeding grounds,
- Source of sediment.

11.5.2. Uses of seaweeds

- Seaweeds are important as food for humans, feed for animals, and fertilizer for plants.
- Seaweeds are used as a drug for goiter treatment, intestinal and stomach disorders.
- Products like agar-agar and alginates, iodine which are of commercial value, are extracted from seaweeds.
- By the biodegradation of seaweeds methane like economically important gases can be produced in large quantities.
- Extracts of some seaweed species show antibacterial activity.
- Seaweeds are also used as the potential indicators of pollution in coastal ecosystem, particularly heavy metal pollution due to their ability to bind and accumulate metals strongly.

11.5.3. Harmful effects of seaweeds

- Rotting seaweed is a potent source of hydrogen sulfide, a highly toxic gas, and has been implicated in some incidents of apparent hydrogen-sulphide poisoning. It can cause vomiting and diarrhoea.

11.5.4. Threats to seaweeds

- Threat are similar to that of sea grass.

◆ ◆ ◆ ◆ ◆ ◆

CHAPTER - 12

PROTECTED AREA NETWORK

12.1. PROTECTED AREAS (PA)

- The adoption of a National Policy for Wildlife Conservation in 1970 and the enactment of the Wildlife (Protection) Act in 1972 lead to a significant growth in the protected areas network, from 5 national parks and 60 sanctuaries to a network of 669 Protected Areas including 102 National Parks, 515 Wildlife Sanctuaries, 49 Conservation Reserves and 4 Community Reserves covering a total of 1,61,583 km^2 of geographical area of the country which is approximately 4.92%.
- The network was further strengthened by a number of national conservation projects, notably Project Tiger, project elephant, crocodile Breeding and Management Project, etc.

12.2. WILD LIFE SANCTUARY (WLS)

- The Wild Life (Protection) Act of 1972 provided for the declaration of certain areas by the State Government as wildlife sanctuaries if the area was thought to be of adequate ecological, geomorphological and natural significance. There are over 500 wildlife sanctuaries in the country, of which Tiger Reserves are governed by Project Tiger.
- The Central Government may also declare a sanctuary under certain conditions.

National Park (NP)

- The Wild Life (Protection) Act (WPA) of 1972 provided for the declaration of National Parks by the State Government in addition to the declaration of wildlife sanctuaries.
- National Parks are declared in areas that are considered to be of adequate ecological, geomorphological and natural significance although within the law, the difference in conservation value of a National Park from that of a sanctuary is not specified in the WPA 1972.

Difference between the two

- National Parks enjoy a greater degree of protection than sanctuaries.
- Certain activities which are regulated in sanctuaries, such as grazing of livestock, are prohibited in National Parks.
- Wildlife sanctuary can be created for a particular species (for e.g. grizzled giant squirrel w.l.s in srivalliputhur) whereas the national park is not primarily focused on a particular species.
- The Central Government may also declare a National Park under certain conditions

12.2.1. General Provision for Sanctuary and National Park

Declaration of the Protected Area by the State Government:

- **Initial Notification:** The State Government may, by notification, declare its intention to constitute any area within or outside any reserve forest as a sanctuary/National Park if it considers that such area is of adequate ecological, faunal, floral, geomorphological, natural or zoological significance, for the purpose of protecting, propagating or developing wild life or its environment.
- **Final notification:** After the initial notification has been issued and the period for preferring claims has elapsed, the State Government may issue a notification specifying the limits of the area which shall be comprised within the sanctuary and declare that the said area shall be a sanctuary/ National park from such date as may be specified in the notification.

Do you know?

Spiders can't chew or swallow inject their prey with poison using their fangs. The poison turns the insides of insect to a watery goop and the spider just sucks it up.

Declared by the Central Government:

- The Central Government may, if it is satisfied that an area is of adequate ecological, faunal, floral, geomorphological, natural or zoological significance, for the purpose of protecting, propagating or developing wild life or its environment, declare it a sanctuary/ National Park by notification.

Boundaries

- The notification shall specify, as nearly as possible, the situation and limits of such area.
- In cases where territorial waters is included, the limits shall be determined in consultation with the Chief Naval Hydrographer of the Central Government, after taking adequate measures to protect the occupational interests of the local fishermen.
- No alteration of boundaries of a sanctuary/ National Park shall be made except on recommendation of the National Board for Wild Life.
- (The Amendment Act of 1991 provided for the inclusion of territorial waters in areas to be declared as sanctuaries for the protection of off-shore marine flora and fauna).

Settlement of rights

- The State Government shall make alternative arrangements required for making available fuel, fodder and other forest produce to the persons affected, in terms of their rights as per the Government records.
- The State Government appoints an officer as a 'Collector' under the Act to inquire into and determine the existence, nature and extent of rights of any person in or over the land comprised within the sanctuary/ National Park which is to be notified.
- After the issue of a notification for declaration of the Protected Area, no right shall be acquired in, on or over the land comprised within the limits of the area specified in such notification, except by succession, testamentary or intestate.

Do you know?

The term "crocodilians" refers to members of three families: the Family Crocodylidae (crocodiles), Family Alligatoridae (alligators and caimans) and Family Gavialidae (gharial). The term "crocodiles" refers only to crocodiles.

Claim of rights:

- In the case of a claim to a right in or over any land referred to, the Collector shall pass an order admitting or rejecting the same in whole or in part
- If such claim is admitted in whole or in part, the Collector may either
  (a) exclude such land from the limits of the proposed sanctuary or
  (b) proceed to acquire such land or rights, except where by an agreement between the owner of such land or holder of rights and the Government, the owner or holder of such rights has agreed to surrender his rights to the Government, in or over such land, and on payment of such compensation, as is provided in the Land Acquisition Act, 1894
  (c) allow, in consultation with the Chief Wild Life Warden, the continuation of any right of any person in or over any land within the limits of the sanctuary

Entry into the Protected Area

- No person other than:-
  1. A public servant on duty
  2. A person who has been permitted by the Chief Wild Life Warden or the authorized officer to reside within the limits of the sanctuary/National Park
  3. A person who has any right over immovable property within the limits of the sanctuary/ National Park
  4. A person passing through the sanctuary/ National Park along a public highway
  5. The dependents of the person referred to in clause (a), (b) or (c) above,
- Shall enter or reside in the sanctuary/National Park, except under and in accordance with the conditions of a permit granted.

Grant of permit for entry:

- The Chief Wild Life Warden may, on application, grant to any person a permit to enter or reside in a sanctuary/National Park for all or any of the following purposes:
  - investigation or study of wildlife and purposes ancillary or incidental thereto
  - photography
  - scientific research
  - tourism
  - transaction of lawful business with any person residing in the sanctuary

- The Chief Wild Life Warden shall be the authority who shall control, manage and maintain all Protected Areas.
- The National Board for Wild Life may make recommendations on the setting up of and management of National Parks, Sanctuaries and other protected areas and on matters relating to restriction of activities in those areas.
- The State Board for Wild Life shall advise the State Government on the selection and management of areas to be declared as protected areas.

Do you know?

The extinct rhinos were also more widespread, occurring in North America and Europe in addition to Africa and Asia. In the past, rhinos were not confined to the tropics but extended into temperate and even arctic regions.

12.3. CONSERVATION RESERVE AND COMMUNITY RESERVES

- Conservation Reserve and Community Reserves are the outcome of Amendments to the Wild life protection act in 2003.
- It provided for a mechanism to provide recognition and legal backing to the community initiated efforts in wildlife protection.
- It provides for a flexible system wherein the wildlife conservation is achieved without compromising the community needs.

12.3.1. Conservation Reserves

- The Amendment Act of 2003 provided for the creation of a new type of protected area called a Conservation Reserve.
- It is an area owned by the State Government adjacent to National Parks and sanctuaries for protecting the landscape, seascape and habitat of fauna and flora. It is managed through a Conservation Reserve Management Committee
- The State Government may, after having consultations with the local communities, declare any area owned by the Government as conservation reserve.
- Tiruppadaimarathur conservation reserve in Tirunelveli, tamil nadu is the first conservation reserve established in the Country. It is an effort of the village community to protect the birds nesting in their village and acted for declaration of conservation reserve.

12.3.2 Community Reserve

- The Amendment Act of 2003 provided for the creation of a new type of protected area called a Community Reserve.
- The State Government may notify any community land or private land as a Community Reserve, provided that the members of that community or individuals concerned are agreeable to offer such areas for protecting the fauna and flora, as well as their traditions, cultures and practices.
- The declaration of such an area is aimed at improving the socio-economic conditions of the people living in such areas as well as conserving wildlife. The Reserve is managed through a Community Reserve Management Committee
- The State Government may, where the community or an individual has volunteered to conserve wildlife and its habitat, declare the area by notification as community reserve.
- No change in land use pattern shall be made within the Community Reserve, except in accordance with a resolution passed by the Management Committee and approval of the same by the State Government

12.4. COASTAL PROTECTED AREAS

- It aims to protect and conserve the natural marine ecosystems in their pristine condition.
- Marine Protected Area (MPA) as "any area of intertidal or sub tidal terrain, together with its overlaying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment" - IUCN.
- Marine productivity in India is concentrated in small areas of coral reefs, lagoons, mangroves, estuaries and seagrass beds around the coast, which provides rich feeding and breeding ground for fish and other marine life.
- MPA protects the vital life support processes of the sea and also ensures sustainable productivity and fish production.
- The MPAs in marine environment in India are primarily classified into following three categories:
- Category-I: This covers National Parks and Sanctuaries and having entire areas in intertidal/ sub-tidal or mangroves, coral reefs, creeks, seagrass beds, algal beds, estuaries, lagoons.

- Category-II: This includes Islands, which have major parts in marine ecosystem and some part in terrestrial ecosystem.
- Category-IIIA: This includes sandy beaches beyond intertidal line but occasionally interacting with the seawater.
- Category-IIIB: This includes ever green or semi ever green forests of Islands.
- The Marine Protected Areas (MPAs) in India comprise of a 33 national parks and wildlife sanctuaries designated under the Wildlife (Protection) Act, 1972, encompassing a few of the country's richest coastal habitats.
- Marine National Park and Marine Sanctuary in the Gulf of Kutch form one unit (one MPA). Similarly Bhitarkanika National Park and Bhitarkanika Sanctuary are an integral part of one MPA. Thus, there a total of 31 MPAs in India.
- MPAs cover less than 4.01 % of the total area of all Protected Areas of India.

Do you know?

- The United Nations General Assembly (UNGA) declared 2010-2020 as the United Nations Decade for Deserts and the Fight against Desertification, to raise awareness about desertification, land degradation and drought.

12.5. SACRED GROVES OF INDIA

- Sacred groves comprise of patches of forests or natural vegetation – from a few trees to forests of several acres – that are usually dedicated to local folk deities.
- These spaces are protected by local communities because of their religious beliefs and traditional rituals that run through several generations.
- The degree of sanctity of the sacred forests varies from one grove to another. In some forests even the dry foliage and fallen fruits are not touched.
- People believe that any kind of disturbance will offend the local deity, causing diseases/natural calamities or failure of crops. For example, the Garo and the Khasi tribes of northeastern India completely prohibit any human interference in the sacred groves. In other groves, deadwood or dried leaves may be picked up, but the live tree or its branches are never cut. For example, the Gonds of central India prohibit the cutting of a tree but allow fallen parts to be used.

12.5.1. Classification of Sacred Groves

- Traditional Sacred Groves – It is the place where the village deity resides, who is represented by an elementary symbol
- Temple Groves – Here a grove is created around a temple and conserved.
- Groves around the burial or cremation grounds.

12.5.2. Ecological Significance

- Conservation of Biodiversity – The sacred groves are important repositories of floral and faunal diversity that have been conserved by local communities in a sustainable manner. They are often the last refuge of endemic species in the geographical region.
- Recharge of aquifers – The groves are often associated with ponds, streams or springs, which help meet the water requirements of the local people. The vegetative cover also helps in the recharging the aquifers.
- Soil conservation - The vegetation cover of the sacred groves improves the soil stability of the area and also prevents soil erosion.

12.5.3. Distribution of Sacred Groves in India

- In India, sacred groves are found all over the country and abundantly along the western ghats in the states of Kerala and Karnataka.

12.5.4. Threats to the Sacred Groves

- The threats vary from one region to the other and even from one grove to the other. But the common threats identified are:
- Disappearance of the traditional belief systems, which were fundamental to the concept of sacred groves. These systems and their rituals are now considered mere superstition.
- Sacred groves in many parts of our country have been destroyed due to rapid urbanization and developmental interventions such as roads, railways tracks, dams including commercial forestry. Encroachment has led to the shrinkage of some of the largest groves in the country.
- Many groves are suffering due to 'Sanskritisation' or the transformation of the primitive forms of nature worship into formal temple worship.
- Invasion by exotic weeds such as Eupatorium odoratum, Lantana camara and Prosopis juliflora is a serious threat to some groves.
- Pressures due to increasing livestock and fuelwood collection.

12.5.5. List of Sacred Groves

Sl.No.	State	Local term for Sacred Groves	No. of sacred groves
1	Andhra Pradesh	**Pavithravana**	580
2	Arunachal Pradesh	**Gumpa Forests** (attached to Buddhist monestries)	101
3	Goa	**Deorai, Pann**	55
4	Jharkhand	**Sarana**	29
5	Karnataka	**Devara Kadu**	1531
6	Kerala	**Kavu, Sara Kavu**	299
7	Maharashtra	**Devrai, Devrahati,** Devgudi	2820
8	Manipur	**Gamkhap, Mauhak** (sacred bamboo reserves)	166
9	Meghalaya	**Ki Law Lyngdoh,** Ki Law Kyntang, Ki Law Niam	101
10	Orissa	**Jahera, Thakuramma**	169
11	Puducherry	**Kovil Kadu**	108
12	Rajasthan	**Orans, Kenkris, Jogmaya**	560
13	Tamil Nadu	**Swami shola, Koilkadu**	752
14	UttaraKhand	**Deo Bhumi, Bugyal** (sacred alpine meadows)	22
15	West Bengal	**Garamthan, Harithan,** Jahera, Sabitrithan, Santalburithan	39

Similarly several water bodies are declared sacred by people. This indirectly leads to protection of aquatic flora and fauna. (E.g. **khecheoprai lake** in Sikkim)

12.6. EXPORT - PROHIBITED GOODS

- The prohibited items are not permitted to be exported. An export licence will not be given in the normal course for goods in the prohibited category.
- The following are the items probited in the flora and fauna category:
  - All wild animals, animal articles including their products and derivatives (excluding those for which ownership certificates have been granted and also those required for transactions for education, scientific research and management under Wild Life (Protection) Act, 1972 including their parts and products).
  - Beef of cows, oxen and calf. Beef in the form of offal of cows, oxen and calf
  - Meat of buffalo (both male and female) fresh and chilled and frozen
  - Peacock Tail Feathers & its Handicrafts and articles
  - Shavings & Manufactured Articles of shavings of Shed Antlers of Chital and Sambhar
  - Sea shells
  - Wood and wood products
  - Fuel wood
  - Wood charcoal
  - Sandalwood in any form,(but excluding finished handicraft products of sandalwood, machine finished sandalwood products, sandalwood oil):
  - Red Sanders wood, Value added products of Red Sanders
  - Mechanical, chemical and semi chemical wood pulp

Do you know?

- The Marble Palace Zoo in Calcutta city which was established in the year 1854 is the oldest existing zoo in the country.
- Delhi has the largest fleet of busses operating on compressed natural gas, which is a successful example of low-carbon sustainable transport
- India maintains and reports ozone depleting substance (ODS) data on year to year basis.
- Nesting sites of an amphibious snake is reported from the shores of North Andaman Islands.
- Traditional Wetland agriculture (locally known as pokkali in Kerala and Gazhani in Karnataka)

GLOBAL INITIATIVE

12.7. THE MAN AND BIOSPHERE (MAB)

- The Man and the Biosphere (MAB) Programme is an Intergovernmental Scientific Programme aiming to set a scientific basis for the improvement of the relationships between people and their environment globally.
- Launched in the early 1970s, it proposes an interdisciplinary research agenda and capacity building that target the ecological, social and economic dimensions of biodiversity loss and the reduction of this loss.
- Concerned with problems at the interface of scientific, environmental, societal and development issues, MAB combines natural and social sciences, economics and education to improve human livelihoods and safeguard natural ecosystems, thus promoting innovative approaches to economic development that is socially and culturally appropriate and environmentally sustainable.
- The agenda of the MAB Prorgamme is defined by its main governing body, the International Coordinating Council in concertation with the broader MAB Community.
- Sub-programmes and activities focus on specific ecosystems: mountains; drylands; tropical forests; urban systems; wetlands; and marine, island and coastal ecosystems. Interdisciplinary and cross-sectoral collaboration, research and capacity–building are promoted.
- For implementation of its interdisciplinary work on-ground, MAB relies on the World Network of Biosphere Reserves, and on thematic networks and partnerships for knowledge-sharing, research and monitoring, education and training, and participatory decision-making.
- The MAB Programme develops the basis within the natural and social sciences for the rational and sustainable use and conservation of the resources of the biosphere and for the improvement of the overall relationship between people and their environment.
- It predicts the consequences of today's actions on tomorrow's world and thereby increases people's ability to efficiently manage natural resources for the well-being of both human populations and the environment.
- By focusing on sites internationally recognized within the World Network of Biosphere Reserves, the MAB Programme strives to:
  - identify and assess the changes in the biosphere resulting from human and natural activities and the effects of these changes on humans and the environment, in particular in the context of climate change;
  - study and compare the dynamic interrelationships between natural/near-natural ecosystems and socio-economic processes, in particular in the context of accelerated loss of biological and cultural diversity with unexpected consequences that impact the ability of ecosystems to continue to provide services critical for human well-being;
  - ensure basic human welfare and a liveable environment in the context of rapid urbanization and energy consumption as drivers of environmental change;
  - promote the exchange and transfer of knowledge on environmental problems and solutions, and to foster environmental education for sustainable development.

Do you know?

- Paints and dressings do not help to cure the tree wound, some actually speed up the decay.
- The death of one 70-year old tree would return over three tons of carbon to the atmosphere. Do cut!!
- The cottonwood tree seed is the seed that stays in flight the longest.
- Aloe vera is also called as fountain of youth.
- During periods of increased or decreased temperature, cracks may develop in the tree trunk – referred to as frost cracks and sun cracks. Both can lead to decay.

12.8. BIOSPHERE RESERVE (BR)

- The International Co-ordinating Council (ICC) of UNESCO, November, 1971, introduced the designation 'Biosphere Reserve' for natural areas. Functions of BRs were given concrete shape in MAB Project area of "Conservation of natural areas and of the genetic material they contain" (UNESCO, 1972). The concept of Biosphere Reserves was refined by a Task Force of UNESCO's MAB Programme in 1974, and BR network was formally launched in 1976.

12.8.1. Definition

- ➢ Biosphere Reserve (BR) is an international designation by UNESCO for representative parts of natural and cultural landscapes extending over large area of terrestrial or coastal/marine ecosystems or a combination thereof.
- ➢ BRs are special environments for both people and the nature and are living examples of how human beings and nature can co-exist while respecting each others' needs.
- ➢ Biosphere reserves are sites established by countries and recognized under UNESCO's Man and the Biosphere (MAB) Programme to promote sustainable development based on local community efforts and sound science.
- ➢ As places that seek to reconcile conservation of biological and cultural diversity and economic and social development through partnerships between people and nature, they are ideal to test and demonstrate innovative approaches to sustainable development from local to international scales.

12.8.2. Biosphere reserves are thus globally considered as:

- sites of excellence where new and optimal practices to manage nature and human activities are tested and demonstrated;
- tools to help countries implement the results of the World Summit on Sustainable Development and, in particular, the Convention on Biological Diversity and its Ecosystem Approach;
- Learning sites for the UN Decade on Education for Sustainable Development.
- After their designation, biosphere reserves remain under national sovereign jurisdiction, yet they share their experience and ideas nationally, regionally and internationally within the World Network of Biosphere Reserves (WNBR).

Do you know?

- ➢ The forests in the country have been classified into 16 major types and 251 subtypes on the basis of climatic and edaphic features.
- ➢ Slender loris (primate) found only in the tropical rainforests of Southern India and Sri Lanka.
- ➢ The Indian star tortoise found in scrub forests of India and Sri Lanka

12.8.3. Characteristics of Biosphere reserve

- ➢ The characteristic features of Biosphere Reserves are:

(1) Each Biosphere Reserves are protected areas of land and/or coastal environments wherein people are an integral component of the system.

- Together, they constitute a worldwide network linked by International understanding for exchange of scientific information.

(2) The network of BRs includes significant examples of biomes throughout the world.

(3) Each BR includes one or more of the following categories:-

(i) BRs are representative examples of natural biomes.

(ii) BRs conserve unique communities of biodiversity or areas with unusual natural features of exceptional interest. It is recognized that these representative areas may also contain unique features of landscapes, ecosystems and genetic variations e.g. one population of a globally rare species; their representativeness and uniqueness may both be characteristics of an area.

(iii) BRs have examples of harmonious landscapes resulting from traditional patterns of land-use.

(iv) BRs have examples of modified or degraded ecosystems capable of being restored to more natural conditions.

(v) BRs generally have a non-manipulative core area, in combination with areas in which baseline measurements, experimental and manipulative research, education and training is carried out. Where these areas are not contiguous, they can be associated in a cluster.

12.8.4. Functions of Biosphere Reserves

Conservation

- ➢ To ensure the conservation of landscapes, ecosystems, species and genetic variations.
- ➢ To encourage the traditional resource use systems;
- ➢ To understand the patterns and processes of functioning of ecosystems;
- ➢ To monitor the natural and human-caused changes on spatial and temporal scales;

Development

- To promote, at the local level, economic development which is culturally, socially and ecologically sustainable.
- To develop the strategies leading to improvement and management of natural resources;

Logistics support

- To provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development
- Sharing of knowledge generated by research through site specific training and education; and
- Development of community spirit in the management of natural resources.

Beneficiaries

- Direct Beneficiaries - local people and the ecological resources of the Biosphere Reserves
- indirect beneficiaries - world community.

Biosphere Reserves: an Indian approach

- It is this ecological diversity that makes India as one of the mega-diversity regions on the globe. Efforts are on to designate at least one Biosphere Reserve in each of the Biogeographic Provinces.

12.8.5. National Biosphere Reserve Programme.

- The national Biosphere Reserve Programme was initiated in 1986.

Aim

- To serve as wider base for conservation of entire range of living resources and their ecological foundations in addition to already established protected area network system
- To bring out representative ecosystems under conservation and sustainable use on a long term basis.
- To ensure participation of local inhabitants for effective management and devise means of improving livelihood of the local inhabitants through sustainable use.
- To integrate scientific research with traditional knowledge of conservation, education and training as a part of the overall management of BR.
- The Core Advisory Group of Experts, constituted by Indian National MAB Committee identified and prepared a preliminary inventory of 14 potential sites for recognition as BRs in 1979. Subsequently additional BR sites were proposed by the National Committee/State Governments, Experts.

Objectives

- It may be noted that BRs are not a substitute or alternative, but a re-enforcement to the existing protected areas. The objectives of the Biosphere Reserve programme, as envisaged by the Core Group of Experts, are as follows:
- To conserve the diversity and integrity of plants and animals within natural ecosystems;
- To safeguard genetic diversity of species on which their continuing evolution depends;
- To provide areas for multi-faceted research and monitoring;
- To provide facilities for education and training; and
- To ensure sustainable use of natural resources through most appropriate technology for improvement of economic well-being of the local people.
- These objectives should be oriented in such a way that the BRs are the Units wherein the Biological, socio-economic and cultural dimension of conservation are integrated together into a realistic conservation strategy.

12.8.6. Criteria for selection of BRs

- The criteria for selection of sites for BRs as laid down by the Core Group of Experts in 1979 are listed below:

Primary criteria

- A site that must contain an effectively protected and minimally disturbed core area of value of nature conservation and should include additional land and water suitable for research and demonstration of sustainable methods of research and management.
- The core area should be typical of a biogeographical unit and large enough to sustain viable populations representing all tropic levels in the ecosystem.

Do you know?

Frogs are found all over the world, and in every climate, except Antarctica. Frogs cannot live in the sea or any salt water.

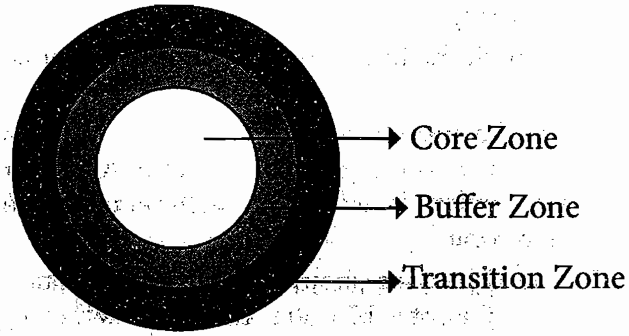
Secondary criteria

- Areas having rare and endangered species
- Areas having diversity of soil and micro-climatic conditions and indigenous varieties of biota.
- Areas potential for preservation of traditional tribal or rural modes of living for harmonious use of environment.

12.8.7. Structure and Design of Biosphere Reserves

- In order to undertake complementary activities of biodiversity conservation and development of sustainable management aspects, Biosphere Reserves are demarcated into three inter-related zones.

1. The Core Zone:



- The core zone should be kept absolutely undisturbed. It must contain suitable habitat for numerous plant and animal species, including higher order predators and may contain centres of endemism. Core areas often conserve the wild relatives of economic species and also represent important genetic reservoirs. The core zones also contain places of exceptional scientific interest. A core zone secures legal protection and management and research activities that do not affect natural processes and wildlife are allowed. Strict nature reserves and wilderness portions of the area are designated as core areas of BR. The core zone is to be kept free from all human pressures external to the system.

2. The Buffer Zone:

- Buffer Zone adjoins or surrounds core zone. Its uses and activities are managed in ways that protect the core zone. These uses and activities include restoration, demonstration sites for enhancing value addition to the resources, limited recreation, tourism, fishing and grazing, which are permitted to reduce its effect on core zone. Research and educational activities are to be encouraged. Human activities, if natural within BR, are likely to be permitted to continue if these do not adversely affect the ecological diversity.

3. The Transition Zone:

- The Transition Zone is the outermost part of a Biosphere Reserve. This is usually not delimited one and is a zone of cooperation where conservation, knowledge and management skills are applied and uses are managed in harmony with the purpose of the Biosphere Reserve. This includes settlements, crop lands, managed forests and area for intensive recreation, and other economic uses characteristic of the region.
- (In Buffer Zone and the Transition Zones, manipulative macro-management practices are used. Experimental research areas are used for understanding the patterns and processes in the ecosystem. Modified or degraded landscapes are included as rehabilitation areas to restore the ecology in a way that it returns to sustainable productivity).

12.8.8. How Biosphere Reserves are different from protected areas?

- BR is not intended to replace existing protected areas but it widens the scope of conventional approach of protection and further strengthens the Protected Area Network.
- Existing legally protected areas (National Parks, Wildlife Sanctuary, Tiger Reserve and reserve/protected forests) may become part of the BR without any change in their legal status.
- On the other hand, inclusion of such areas in a BR will enhance their national value.
- It, however, does not mean that Biosphere Reserves are to be established only around the National Parks and Wildlife Sanctuaries.

Do you know?

Dead and decaying trees on the ground replenish soils by returning important nutrients, and provide food resources for many types of wildlife.

However, the Biosphere Reserves differ from protected areas due to their emphasis on :

(i) Conservation of overall biodiversity and landscape, rather than some specific flagship species, to allow natural and evolutionary processes to continue without any hindrance.

(ii) Different components of BRs like landscapes, habitats, and species and land races.

(iii) Developmental activities, and resolution/mitigation of conflicts between development and conservation,

(iv) Increase in broad-basing of stakeholders, especially local people's participation and their Training, compared to the features of scheme on Wildlife Sanctuaries and National Parks.

(v) Sustainable environment friendly development, and sustained coordination amongst different development organizations and agencies.

(vi) Research and Monitoring to understand the structure and functioning of ecological system and their mode of reaction when exposed to human intervention.

- The Indian National Man and Biosphere Committee constituted by the Central Govt. identifies new sites, advises on policies and programmes, lays down guidelines, reviews progress and guidelines in the light of evaluation studies and feed back.
- The Management of Biosphere Reserves is the responsibility of the concerned State/UT with necessary financial assistance, guidelines for management and Technical expertise provided by the Central Government.
- BR are internationally recognized within the framework of UNESCO's Man and Biosphere (MAB) programme, after receiving consent of the participating country.

Do you know?

The United Nations General Assembly (UNGA) declared 2011-2020 as the United Nations Decade on Biodiversity and United Nations Decade for Deserts and the Fight against Desertification.

12.9. WORLD NETWORK OF BIOSPHERE RESERVES (WNBR)

12.9.1. The World Network

- In order to facilitate cooperation, BRs are admitted into International network by International Coordinating Council (ICC) of the Man and Biosphere (MAB) Programme of UNESCO on the request of the participating country subject to their fulfillment of prescribed criteria.
- The BRs remain under the sole sovereignty of the concerned country/state where it is situated, and participation in World Network is voluntary.
- Delisting from international Network is done as an exception on ground of violation of obligation for conservation and sustainable development of Biosphere Reserves after consulting the concerned Government.
- The MAB programme's primary achievement is the creation in 1977 of the World Network of Biosphere Reserves.
- Composed of 610 biosphere reserves in 117 countries, including 12 transboundary sites, the WNBR of the MAB Programme promotes North-South and South-South collaboration and represents a unique tool for international co-operation through sharing knowledge, exchanging experiences, building capacity and promoting best practices.

12.9.2. Vision

- The World Network of Biosphere Reserves of the MAB Programme consists of a dynamic and interactive network of sites of excellence.
- It fosters the harmonious integration of people and nature for sustainable development through
  - participatory dialogue;
  - knowledge sharing;
  - poverty reduction and
  - human well-being improvements;
  - respect for cultural values and society's ability to cope with change - thus contributing to the Millenium Development Goals.
- Accordingly, the WNBR is one of the main international tools to develop and implement sustainable development approaches in a wide array of contexts.

12.9.3. Mission

- To ensure environmental, economic and social (including cultural and spiritual) sustainability through:
  - the development and coordination of a worldwide network of places acting as demonstration areas and learning sites with the aim of maintaining and developing ecological and cultural diversity, and securing ecosystem services for human well-being;

- the development and integration of knowledge, including science, to advance our understanding of interactions between people and the rest of nature;
- building global capacity for the management of complex socio-ecological systems, particularly through encouraging greater dialogue at the science-policy interface; environmental education; and multi-media outreach to the wider community.

12.9.4. Designation of Biosphere Reserves

Article 5 of the 1995 Statutory Framework of the World Network of Biosphere Reserves, states the designation procedure for biosphere reserves. It reads as follows:

1. Biosphere reserves are designated for inclusion in the Network by the International Co-ordinating Council (ICC) of the MAB programme in accordance with the following procedure:
    - States, through National MAB Committees where appropriate, forward nominations with supporting documentation to the secretariat after having reviewed potential sites, taking into account the criteria as defined in Article 4;
    - the secretariat verifies the content and supporting documentation: in the case of incomplete nomination, the secretariat requests the missing information from the nominating State;
    - nominations will be considered by the Advisory Committee for Biosphere Reserves for recommendation to ICC;
    - ICC of the MAB programme takes the decision on nominations for designation.
    - The Director-General of UNESCO notifies the State concerned of the decision of ICC.
2. States are encouraged to examine and improve the adequacy of any existing biosphere reserve, and to propose extension as appropriate, to enable it to function fully within the Network. Proposals for extension follow the same procedure as described above for new designations.
3. Biosphere reserves which have been designated before the adoption of the present Statutory Framework are considered to be already part of the Network. The provisions of the Statutory Framework therefore apply to them.

12.10. BIODIVERSITY HOT SPOTS

- Biodiversity hot spot concept was put forth by Norman Myers in 1988
- To qualify as a hot spot, a region must meet two strict criteria:
    - a. Species endemism - it must contain at least 1,500 species of vascular plants (> 0.5% of the world's total) as endemics, and
    - b. Degree of threat - it has to have lost at least 70% of its original habitat.
- Each biodiversity hot spot represents a remarkable universe of extraordinary floral and faunal endemicity struggling to survive in rapidly shrinking ecosystems.
- Over 50 percent of the world's plant species and 42 percent of all terrestrial vertebrate species are endemic to the 34 biodiversity hot spots.

12.10.1. The hottest hot spots

- Some hot spots are much richer than others in terms of their numbers of endemics.
- Five key factors have been taken into consideration and those biodiversity hot spot, tops the list with respect to these five factors are considered as hottest hot spots.

Factors

1. Endemic plants
2. Endemic vertebrates
3. Endemic plants/area ratio (species per 100km^2)
4. Endemic vertebrates/area ratio (species per 100km^2)
5. Remaining primary vegetation as % of original extent

The eight hottest hot spots in terms of five factors

1. Madagascar
2. Philippines
3. Sundaland
4. Brazil's Atlantic Forest
5. Caribbean
6. Indo-Burma
7. Western Ghats/Sri Lanka
8. Eastern Arc and Coastal Forests of Tanzania/Kenya

These eight 'hottest hot spots', appear at least three times in the top ten listings for each factor.

Do you know?

All snakes and lizards have two penises

12.10.2. Indian Biodiversity Hot Spots.

- There are 3 biodiversity hot spots present in India. They are:
  1. The Eastern Himalayas
  2. Indo- Burma and
  3. The western Ghats & Sri Lanka

Do you know?

- Spider silk, it looks like one thread but it is actually many thin threads that stick together. As soon as this liquid silk hits the air it hardens.
- All spiders have fangs! their poison is strong enough to kill their prey. few spiders with poison strong enough to cause pain or even some nerve damage in humans.
- Spiders have 48 knees. Yup, count them...eight legs with six joints on each.
- Spider's legs are covered with many hairs. The hairs pick up vibrations and smells from the air.

1. The Eastern Himalayas Hot Spot

About the region:

- The Eastern Himalayas is the region encompassing Bhutan, northeastern India, and southern, central, and eastern Nepal. The region is geologically young and shows high altitudinal variation.
- The abrupt rise of the Himalayan Mountains from less than 500 meters to more than 8,000 meters results in a diversity of ecosystems that range from alluvial grasslands and subtropical broad leaf forests along the foothills to temperate broad leaf forests in the mid hills, mixed conifer and conifer forests in the higher hills, and alpine meadows above the tree line.

Biodiversity:

- The Eastern Himalayan hotspot has nearly 163 globally threatened species (both flora and fauna) including the One-horned Rhinoceros, the Wild Asian Water buffalo.
- There are an estimated 10,000 species of plants in the Himalayas, of which one-third are endemic and found nowhere else in the world.
- Many plant species are found even in the highest reaches of the Himalayan mountains. For example, a plant species Ermania himalayensis was found at an altitude of 6300 metres in northwestern Himalayas.
- A few threatened endemic bird species such as the Himalayan Quail, Cheer pheasant, Western tragopan are found here, along with some of Asia's largest and most endangered birds such as the Himalayan vulture and White-bellied heron.
- The Himalayas are home to over 300 species of mammals, a dozen of which are endemic. Mammals like the Golden langur, The Himalayan tahr, the pygmy hog, Langurs, Asiatic wild dogs, sloth bears, Gaurs, Muntjac, Sambar, Snow leopard, Black bear, Blue sheep, Takin, the Gangetic dolphin, wild water buffalo, swamp deer call the Himalayan ranged their home.

2. Indo-Burma

Region:

- The Indo-Burma region encompasses several countries.
- It is spread out from Eastern Bangladesh to Malaysia and includes North-Eastern India south of Brahmaputra river, Myanmar, the southern part of China's Yunnan province, Lao People's Democratic Republic, Cambodia, Vietnam and Thailand.
- The Indo-Burma region is spread over 2 million sq. km of tropical Asia.
- Since this hotspot is spread over such a large area and across several major landforms, there is a wide diversity of climate and habitat patterns in this region.

Biodiversity:

- Much of this region is still a wilderness, but has been deteriorating rapidly in the past few decades.
- In recent times, six species of large mammals have been discovered here: Large-antlered muntjac, Annamite muntjac, Grey-shanked douc, Annamite striped rabbit, Leaf deer, and the Saola.
- This region is home to several primate species such as monkeys , langurs and gibbons with populations numbering only in the hundreds.
- Many of the species, especially some freshwater turtle species, are endemic.
- Almost 1,300 bird species exist in this region including the threatened white-eared night-heron, the grey-crowned crocias, and the orange-necked partridge.
- It is estimated that there are about 13,500 plant species in this hotspot, with over half of them endemic. Ginger, for example, is native to this region.

3. Western Ghats and Sri Lanka:

- Western Ghats, also known as the "Sahyadri Hills" encompasses the mountain forests in the southwestern parts of India and highlands of southwestern Sri Lanka.
- The entire extent of hotspot was originally about 1,82,500 square kms, but due to tremendous population pressure, now only 12,445 square Km or 6.8% is in pristine condition.
- The wide variation of rainfall patterns in the Western Ghats, coupled with the region's complex geography, produces a great variety of vegetation types.
- These include scrub forests in the low-lying rainshadow areas and the plains, deciduous and tropical rainforests up to about 1,500 meters, and a unique mosaic of montane forests and rolling grasslands above 1,500 meters.
- In Sri Lanka diversity includes dry evergreen forests to dipterocarpus dominated rainforests to tropical montane cloud forest.
- The important populations include Asian elephant, Niligiri tahr, Indian tigers, lion tailed macaque, Giant squirrel, etc.

12.11. WORLD HERITAGE SITES

- World Heritage Sites means "Sites any of various areas or objects inscribed on the United Nations Educational, Scientific, and Cultural Organisation (UNESCO) World Heritage List".
- The sites are designated as having outstanding universal value under the Convention concerning the Protection of the World Cultural and Natural Heritage.
- This Convention, which was adopted by the UNESCO in 1972 (and enforced in 1975) provides a framework for international cooperation in preserving and protecting cultural treasures and natural areas throughout the world.
- The convention defines the kind of sites which can be considered for inscription of the World heritage list (ancient monuments, museums, biodiversity and geological heritage etc.,), and sets out the duties of the State Parties in identifying potential sites and their role in protecting them.
- Although many World Heritage sites fall into either the 'cultural' or 'natural'categories, a particularly important aspect of the convention is its ability to recognise ladscapes that combine these values, and where the biological and physical aspects of landscape have evolved alongside human activity.
- The first list of World Heritage state was published in 1978.
- The World Heritage Convention reiterates that the protection on sites should be dovetailed with regional planning programmes. This is not happening always. (Agra city developments do not go well the conversation of Taj Mahal is a point).
- "Natural heritage sites are restricted to those natural areas that
    1. furnish outstanding examples of the Earth's record of life or its geologic processes.
    2. provide excellent examples of ongoing ecological and biological evolutionary processes.
    3. contain natural phenomena that are rare, unique, superlative, or of outstanding beauty or
    4. furnish habitats or rare endangered animals or plants or are sites of exceptional biodiversity".
- Until the end of 2004, there were six criteria for cultural heritage and four criteria for natural heritage. In 2005 this was modified so that there is only one set of ten criteria. Nominated sites must be of "outstanding universal value" and meet at least one of the ten criteria. The criteria are given below.

Do you know?

- snakes have very poor eyesight. Snakes use their senses to hunt, escape danger, and to find a mate.
- Although most snakes have teeth, All snakes swallow their food whole. While they do have teeth, the teeth are made for grabbing, hooking and holding their prey, not chewing.

12.11.6.Criteria

I. "to represent a masterpiece of human creative genius";

II. "to exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design?".

III. "to bear a unique or atleast exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared ?;

IV. "to be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates a significat stage(s) in human history";

V. "to be an outstanding example of a traditional human settlemnet, land-use, or sea-use, which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change";

VI. "to be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria).

VII. "to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance";

VIII. "to be outstanding examples representing major stages of Earth's history, including the record of life, significant on-going geological processess in the development of landforms, or significant geomorphic or psysiographic features";

IX. "to be outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystem and communities of plants and animals";

X. "to contain the most important and significant natural habitats for insists conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

➢ The UNESCO funds numerous efforts to preserve and restore World Heritage Sites in developing nations. It maintains also a List of World Heritage Sites in developing nations. It maintains also a List of World Heritage in danger facing threat of pollution and other natural hazards. Sites subject to unusual levels of pollution, natural hazards, or other problems may be placed for restoration. Such designated sites facilitate promotion of tourism.

International Year of Biodiversity

➢ The United Nations declared 2010 to be the International Year of Biodiversity. It is a celebration of life on earth and of the value of biodiversity for our lives.

Slogan

"Biodiversity is variety of life on earth
Biodiversity is life.
Biodiversity is our life".

Objectives of the IYB are

➢ Raise awareness of the importance of conserving biodiversity for human well-being and promote understanding of the economic value of biodiversity

➢ Enhance public knowledge & awareness of the threats to biodiversity and means to conserve it

➢ Promote innovative solutions to reduce the threats to biodiversity

➢ Encourage individuals, organizations and governments to take immediate steps to halt biodiversity loss

➢ Prepare the ground for communicating the post-2010 target(s)

➢ The 'Play for Life' Campaign by UNEP and PUMA (Sports Company) - will use football and African football stars to promote the 2010 International Year of Biodiversity.

Why 2010 matters?

➢ The year 2010 has long been seen as an end goal, a time when we could look back and say, yes, we've done it - that biodiversity, life on Earth, is no longer threatened.

➢ In 2002, Governments set 2010 as a deadline to achieve a significant reduction in the rate of loss of biodiversity for reducing poverty.

➢ The year 2010 is critical because it is time to reflect about what needs to be done if we are to change this trend.

➢ Although the 2010 goal has not been met, it does not mean the future is necessarily bleak.

➢ The 2010 International Year of Biodiversity is a unique opportunity to understand the vital role that biodiversity plays in sustaining life on Earth and to stop this loss.

Do you know?

There is no parrot in India. They are parakeets.

International Day for Biological Diversity - 22 May

- The United Nations proclaimed May 22 as The International Day for Biological Diversity (IDB) to increase understanding and awareness of biodiversity issues.
- Initially 29 December (the date of entry into force of the Convention of Biological Diversity), was designated The International Day for Biological Diversity by the UN General Assembly in late 1993.
- In December 2000, the UN General Assembly adopted 22 May as IDB, to commemorate the adoption of the text of the Convention on 22 May 1992 by the Nairobi Final Act of the Conference for the Adoption of the Agreed Text of the Convention on Biological Diversity.

Do you know?

- Gymnosperms produce their seeds on the surface or tips of an appendage such as a pine cone.
- Angiosperms produce their seeds inside a fruit such as an acorn.
- Dendrochronology is the science of calculating a tree's age by its rings.
- For every five percent of tree cover added to a community, storm water runoff is reduced by approximately two percent.
- "Heat islands," created by tree loss, also exponentially increase air pollutants.
- Aspirin is derived from the bark of a willow tree.

◆◆◆◆◆◆

CHAPTER - 13

CONSERVATION EFFORTS

13.1. PROJECT TIGER

A potential example of conservation of a highly endangered species is the Indian Tiger (Panthera tigris). The fall and rise in the number of Tiger population in India is an index of the extent and nature of conservation efforts.

It is estimated that India had about 40 000 tigers in 1900, and the number declined to a mere about 1800 in 1972.

Hence, Project Tiger centrally sponsored scheme was launched in 1973 with the following objectives:

- To ensure maintenance of available population of Tigers in India for scientific, economic, aesthetic, cultural and ecological value
- To preserve, for all times, the areas of such biological importance as a national heritage for the benefit, education and enjoyment of the people

Aim

(i) Conservation of the endangered species and

(ii) Harmonizing the rights of tribal people living in and around tiger reserves

> **Do you know?**
>
> The scientific name for the tiger is Panthera tigris There are eight subspecies of tiger among the eight, at present five subspecies are present in the wild. They are - Bengal, South China, Indochinese, Sumatran, and Siberian. Three subspecies of tiger—Caspian, Bali, and Javan—are extinct.

13.1.1. Tiger Reserve

- Tiger reserves are areas that are notified for the protection of the tiger and its prey, and are governed by Project Tiger which was launched in the country in 1973.
- Initially 9 tiger reserves were covered under the project, and has currently increased to 42, falling in 17 States (tiger reserve States).
- The State Government shall, on recommendation of the National Tiger Conservation Authority, notify an area as a tiger reserve.
- A Tiger reserve includes:

a) **Core zone**

- Critical tiger habitat areas established, on the basis of scientific and objective criteria.
- These areas are required to be kept as inviolate for the purposes of tiger conservation, without affecting the rights of the Scheduled Tribes or such other forest dwellers.
- These areas are notified by the State Government in consultation with an Expert Committee (constituted for that purpose)

b) **Buffer zone**

- Peripheral area to critical tiger habitat or core area, where a lesser degree of habitat protection is required to ensure the integrity of the critical tiger habitat with adequate dispersal for tiger species.
- It aims at promoting co-existence between wildlife and human activity with due recognition of the livelihood, developmental, social and cultural rights of the local people.
- The limits of such areas are determined on the basis of scientific and objective criteria in consultation with the concerned Gram Sabha and an Expert Committee constituted for the purpose.
- No alteration in the boundaries of a tiger reserve shall be made except on a recommendation of the National Tiger Conservation Authority and the approval of the National Board for Wild Life.
- No State Government shall de-notify a tiger reserve, except in public interest with the approval of the National Tiger Conservation Authority and the approval of the National Board for Wild Life.

13.1.1 National Tiger Conservation Authority (NTCA):

- The Amendment Act of 2006 provides for the constitution of a statutory authority known as the National Tiger Conservation Authority to aid in the implementation of measures for the conservation of the tiger.

Do you know?

No two tigers have exactly the same pattern of stripes. Tigers live alone, except for mothers and their young. A male and female tiger come together to mate, and then go their separate ways.

Powers and functions:

1. To approve the Tiger Conservation Plan prepared by the State Government
2. To evaluate and assess various aspects of sustainable ecology and disallow any ecologically unsustainable land use such as mining, industry and other projects within tiger reserves
3. To lay down normative standards for tourism activities and guidelines for project tiger from time to time for tiger conservation in the buffer and core area of tiger reserves and ensure their due compliance
4. To provide information on protection measures including future conservation plan, estimation of population of tiger and its natural prey species, status of habitats, disease surveillance, mortality survey, patrolling, reports on untoward happenings and such other management aspects as it may deem fit including future plan of conservation
5. To ensure that tiger reserves and areas linking on protected area or tiger reserve with another protected area or tiger reserve are not diverted for ecologically unsustainable uses, except in public interest and with the approval of the National Board for Wild Life.
6. To facilitates and support tiger reserve management in the State for biodiversity conservation initiatives through eco-development and peoples participation as per approved management plans, and to support similar initiatives in adjoining areas consistent with the Central and State laws
7. To ensure critical support including scientific, information technology and legal support for better implementation of the tiger conservation plan
8. To facilitate ongoing capacity building program for skill development of officers and staff of tiger reserves

13.1.3. Estimation of Tiger Populations

- The process of estimating the number of tigers in a given area is called 'Tiger census.'
- This exercise provides us with an estimate of tiger number, density and change in tiger indices - a measure of tiger occupancy in a given area.
- It is conducted at regular intervals to know the current tiger populations and population trends.
- Besides estimating the number of tigers the method also helps to gather information on the density of the tiger populations and associated prey.
- The most commonly used technique in the past was 'Pugmark Census Technique'. In this method the imprints of the pugmark of the tiger were recorded and used as a basis for identification of individuals. Now it is largely used as one of the indices of tiger occurrence and relative abundance.
- Recent methods used to estimate the numbers of tigers are camera trapping and DNA fingerprinting.
- In camera trapping, the photograph of the tiger is taken and individuals are differentiated on the basis of the stripes on the body.
- In the latest technique of DNA fingerprinting, tigers can be identified from their scats.

Do you know?

The Bengal tiger is endangered because it is poached for its body parts to cater to an illegal market. Another reason is habitat loss due to depletion of forest cover interference of humans and encrochment of forest land by people causing fragmentation.

2010 Assessment Methodology

- The All India Tiger Estimation exercise is one of the most crucial components of our national tiger conservation efforts.
- Since 2006, this monitoring exercise is being undertaken every four years.
- This report presents the results of the 2010 National Tiger Assessment, undertaken through a best-in-class scientific process.

- This presents an estimate of India's current tiger population and a broader assessment of our tiger landscapes.
- The three phases of the tiger estimation procedure are as follows:
  - Phase 1: Field data collected at the beat-level (i.e. the primary patrolling unit) by trained personnel using a standardised protocol.
  - Phase 2: Analysis of habitat status of tiger forests using satellite data..
  - Phase 3: Camera trapping was the primary method used, where individual tigers were identified from photographs based on their unique stripe patterns. This information was analysed using a well established scientific framework. Camera trapping was carried out by teams of wildlife biologists and local forest personnel.
- Based on the tiger numbers recorded in sampled sites, an estimate for other contiguous tiger-occupied landscapes, was made. For this, additional information such as tiger signs, prey availability, habitat conditions and human disturbance was used. Thus, the final estimates provide a comprehensive and statistically robust result for the whole country

"Phase IV"

- India has announced a major expansion of its tiger monitoring programme, through 'Phase IV' of the national tiger estimation programme.
- This initiated intensive, annual monitoring of tigers at the tiger reserve level, across 41 protected areas in the country, from November 2011.
- Phase IV of the All India Tiger Estimation exercise began the process of intensive, annual monitoring of important 'source' populations of tigers.
- The methodology is developed by the Wildlife Institute of India (WII) and the National Tiger Conservation Authority (NTCA), in consultation with experts, and will use statistically sound procedures to estimate numbers of both tigers and their prey.
- The tiger monitoring protocol use camera traps, at a density of 25 double-sided cameras per 100 square kilometres, and a minimum trapping effort of 1000 trap nights per 100 square kilometres. **(Note: Tiger reserve - see appendix)**
- This will provide a yearly indication of the status of critical tiger populations around the country, and will be critical to long-term management and conservation of tiger populations.
- Prey population monitoring will be conducted simultaneously, using Distance sampling protocols. Distance sampling will be conducted along line transects already established in phase I, and will use a minimum of 30 spatial replicates for 2 km each, and a total effort of 300 km.

Do you know?

Royal Bengal tiger, is a tiger subspecies native to India, Bangladesh, Nepal and Bhutan, and has been classified as endangered by IUCN as the population is estimated at fewer than 2,500 individuals with a decreasing trend. The Bengal tiger is the national animal of Bangladesh. Panthera tigris is the national animal of India.

Innovations In 2010 National Tiger assessment

- The 2010 National Tiger Assessment has several innovations over previous assessments. These include:
  - Partnerships with civil society organizations
  - Local communities involved in data collection and analysis.
  - Genetic analysis to estimate tiger populations from faecal samples.
  - Along with tigers, co-predators, prey, and habitat quality assessed.
  - Pioneering attempt to estimate tiger populations in Sunderbans Tiger Reserve (West Bengal) using satellite telemetry and sign surveys.
  - First estimation of tiger population in Sahyadri Tiger Reserve (Maharashtra).

Tiger Population Estimates

- The same scientifically robust methods were consistently used in 2006 and 2010. This enabled comparison of results from both estimation exercises and in understanding the trend in tiger numbers.
- The estimated tiger population in 2006 was 1411 and due to conservation efforts it has steadily increased and the tiger population was 1706 in the 2010 tiger estimate.

Do you know?

- Tigers have a lifespan of 10-15 years in the wild, but can live longer than 20 years in captivity.
- They are highly adaptable and range from the Siberian taiga to open grasslands and tropical mangrove swamps.

13.1.4. International Cooperation

- India has a Memorandum of Understanding with Nepal on controlling trans-boundary illegal trade in wildlife and conservation, apart from a protocol on tiger conservation with China.
- The process is on for bilateral protocol with Bangladesh, Bhutan & Myanmar.
- A Global Tiger Forum of Tiger Range Countries has been created for addressing international issues related to tiger conservation.

13.2. PROJECT ELEPHANT

- Project Elephant was launched in February, 1992 as centrally sponsored scheme to assist states having free ranging populations of wild elephants and to ensure long term survival of identified viable populations of elephants in their natural habitats.
- The Project is being mainly implemented in 13 States / UTs , viz. Andhra Pradesh, Arunachal Pradesh, Assam, Jharkhand, Karnataka, Kerala, Meghalaya, Nagaland, Orissa, Tamil Nadu, Uttaranchal, Uttar Pradesh and West Bengal. Small support is also being given to Maharashtra and Chhattisgarh.
- States are being given financial as well as technical assistance in achieving the objectives of the Project. Help is also provided to other states with small populations of elephants for the purpose of census, training of field staff and mitigation of human-elephant conflict.

Do you know?

The hippopotamus, walrus, narwhal, mammoth, Rhino and most commonly Asian and African elephants are poached for their ivory tusk.

Objectives :

- To protect elephants, their habitat & corridors
- To address issues of man-animal conflict
- Welfare of domesticated elephants

Aim

- Ecologically restoring the natural habitats and migratory routes of the elephants
- Mitigation of the increasing conflicts between man and elephants in important habitats and moderating the pressures of human and domestic stock activities in important elephant habitats.
- Developing scientific and planned management measures for conservation of elephants.
- Protecting the elephants from poachers and other unnatural causes of death and preventing illegal ivory trade is also one of the major concerns of the Elephant Project in India
- Researching on issues related to elephants and creating public awareness and education programs for it.
- Eco-development and Veterinary care for the elephants.
- It also aims at maintaining health care and breeding of tamed elephants.
- **(Elephant reserve of India see appendix table no)**

13.2.1. Elephant Corridor

- An elephant corridor is defined as a stretch/ narrow strips of forested (or otherwise) land that connects larger habitats with elephant populations and forms a conduit for animal movement between the habitats. This movement helps enhance species survival and birth rate.
- There are 88 identified elephant corridors in India.
- Out of total 88 corridors, 20 were in south India, 12 in north-western India, 20 in central India, 14 in northern West Bengal and 22 in north-eastern India.
- Of the total, 77.3 per cent is regularly used by elephants. About one-third is of ecologically high priority and remaining two third of medium priority.
- Fragmentation of elephant habitat was severe in northern West Bengal followed by north-western India, north-eastern India and central India respectively. The least fragmentation was noted in south India.
- In south India, 65 per cent of the corridors are in protected area or in reserved forests.

- 90 per cent in central India are jointly under forest, agriculture and settlements, Only 10 per cent are completely under forest area.
- Nationally, only 24 per cent of the corridors are under complete forest cover.

13.2.2. Threats to Elephant Corridors

- The primary threat is the Habitat loss leading to fragmentation and destruction caused by developmental activities like construction of buildings,roeds, railways, holiday resorts and the fixing solar energized electric fencing, etc.
- Coal mining and iron ore mining is the two "single biggest threats" to elephant corridors in central India.
- Orissa, Jharkhand and Chhattisgarh, are mineral-rich states, but also have the highest number of elephant corridors in the country, which makes them known for elephant-man conflicts.
- There is also a serious poaching problem, as elephant ivory from the tusks is extremely valuable.
- Elephants need extensive grazing grounds and most reserves cannot accommodate them. If protected areas are not large enough, elephants may search for food elsewhere. This often results in conflicts with humans, due to elephants raiding or destroying crops.

Do you know?

White tigers are not a separate sub-species, but are white in color due to an expression of recessive genes

13.2.3. Mitigation

- Fusion of the corridors with nearby protected areas wherever feasible; in other cases, declaration as Ecologically Sensitive Areas or conservation reserves to grant protection.
- During the process of securing a corridor, monitoring for animal movement have to be carried out; depending on the need, habitat restoration work shall also be done.
- Securing the corridors involves sensitizing local communities to the option of voluntarily relocation outside the conflict zones to safer areas. It would also have great conservation value, preventing further fragmentation of the continuous forest habitat by encroachment from urban areas, as well as providing continued refuge for tiger, elephant, sambar, marsh crocodile, gharial and many species of bird.

13.2.4. Monitoring of Illegal Killing of Elephants (MIKE)Programme

- Mandated by COP resolution of CITES, MIKE program started in South Asia in the year 2003 with following purpose –
- To provide information needed for elephant range States to make appropriate management and enforcement decisions, and to build institutional capacity within the range States for the long-term management of their elephant populations

Main objectives

1. to measure levels and trends in the illegal hunting of elephants;
2. to determine changes in these trends over time; and
3. to determine the factors causing or associated with such changes, and to try and assess in particular to what extent observed trends are a result of any decisions taken by the Conference of the Parties to CITES

- Under the programme data are being collected from all sites on monthly basis in specified MIKE patrol form and submited to Sub Regional Support Office for South Asia Programme located in Delhi who are assisting Ministry in the implementation of the progremme.

Do you know?

Paraceratherium, the largest land mammal that ever lived, which resembles a very big, muscular giraffe.

13.2.5. Haathi Mere Saathi

- Haathi Mere Saathi is a campaign launched by the Ministry of environment and forest (MoEF) in partnership with the wildlife trust of India (WTI).
- To improve conservation and welfare prospects of the elephant - India's National Heritage Animal.
- The campaign was launched at the "Elephant- 8" Ministerial meeting held in Delhi on 24th May 2011.

- The E-8 countries comprise of India, Botswana, the Republic of Congo, Indonesia, Kenya, Srilanka, Tanzania, and Thailand.
- This public initiative was aimed at increasing awareness among people and developing friendship, companionship between people and elephants.

The campaign mascot 'Gaju'.

- The campaign focuses on various target audience groups including locals near elephant habitats, youth, policy makers, among others.
- It envisions setting up of Gajah (the elephant) centres in elephant landscapes across the country to spread awareness on their plight and invoke people's participation in addressing the threats to them.
- It also plants to build capacity of protection and law enforcement agencies at the ground level, and advocate for policies favouring the pachyderms (the elephant).
- Recommended by the elephant task force (ETF) constituted by the ministry last year, the campaign to "Take Gajah (the elephant) to the prajah (the people)" aims to spread awareness and encourage people's participation in elephant conservation and welfare.

> Tiger, faces threat of extinction, whereas the elephant faces threat of attrition. The elephant Nos. have not increased or decreased drastically but there is a increasing pressure on the elephant habitats and it is a serious concern which has to be addressed by involving people in elephant conservation and welfare through this campaign.

- The Asian elephant is threatened by habitat degradation, conflicts and poaching for ivory. These threats are more intense in India which harbours more than 50% of worlds Asian elephant population.
- India has about 25000 elephants in the wild. Despite this seemingly large number, the elephant particularly the tuskers (male), in India is as threatened as the tiger. There are just about 1200 tuskers left in the country.

> **Do you know?**
>
> The term "blind as a bat" isn't really accurate. Bats have perfectly good eyes for seeing in the daylight. The problem is, they do most of their hunting at night!

13.2.6. Elephant - 8 Ministerial Meeting

- The E-8 ministerial meeting represented regions with all 3 species of elephants, viz.,
  1. Elephas maximus (Asian elephant)
  2. Loxodonta africana (African Bush Elephant)
  3. Loxodonta cyclotis (African Forest Elephant)
- The participants included policy makers, conservationist, scientists, historians, art and culture experts among the participating countries.
- Discussions covered a wide range of issues categorised under three basic themes.
  1. Science and conservation
  2. Management and conservation
  3. Cultural and Ethical perspectives of conservation
- The E-8 countries besides resolving to take necessary steps in the direction of elephant conservation also decided to actively pursue a common Agenda to ensure a long term welfare and survival of all species of elephants in all range countries.
- To realise this global goal, the meeting has called upon all range countries to join hands under
- the umbrella of elephant-50:50 forum. It is the shared vision of 50 states to promote conservation, management and welfare of elephants in the next 50 years.

13.2.7. E-50:50 forum

- The E-8 countries decided to hold the 1st International Congress of E-50:50 forum in early 2013 at New Delhi, India for adopting a common global vision on conservation, management and welfare of elephants across all range countries.

13.3. VULTURE

India has nine species of vultures in the wild. They are the

1. Oriental White-backed Vulture (Gyps bengalensis),
2. Slender billed Vulture (Gyps tenuirostris),
3. Long billed Vulture (Gyps indicus),
4. Egyptian Vulture (Neophron percnopterus),
5. Red Headed Vulture (Sarcogyps calvus),
6. Indian Griffon Vulture (Gyps fulvus),

- Himalayan Griffon (Gyps himalayensis),
- Cinereous Vulture (Aegypius monachus) and
- Bearded Vulture or Lammergeier (Gypaetus barbatus).
- Decline of vulture populations in India was first recorded at the Keoladeo Ghana National Park, Rajasthan
- The decline of Gyps genus in India has been put at 97% (over a 12 year period) by 2005.
- Similar declines have occurred in other countries in Asia, including Nepal and Pakistan.
- In India the population of three species i.e. White-backed Vulture, Slender billed Vulture and Long billed Vulture in the wild has declined drastically over the past decade.
- Red-headed vulture or king vulture, Slender billed Vulture and Long billed Vulture are listed as critically endangered.
- Populations of Egyptian vultures and White-backed Vulture have also undergone decline in India and are now classified as Endangered.
- It is initially thought the drastic decline in population was due to non-availability of food (dead livestock) or an unknown viral epidemic disease, but later on confirmed that decline in population was due to the drug diclofenac.

13.3.1. Diclofenac Sodium as the Probable Cause

- Diclofenac is a non-steroidal anti-inflammatory drug (NSAID) administered to reduce inflammation and to reduce pain in certain conditions.
- NSAIDs are associated with adverse kidney (renal) failure which is caused due to the reduction in synthesis of renal prostaglandins.
- Vultures which were unable to break down the chemical diclofenac, suffer from kidney failure when they eat the carcass of animals which have been administered with the drug - Diclofenac
- Visceral gout, an accumulation of uric acid within tissues and on the surfaces of internal organs, was observed in 85% of dead vultures found. Death caused by renal failure, which is known to occur as a result of metabolic failure or toxic disease.
- "Neck drooping" - vulture exhibit this behaviour for protracted periods over several weeks before collapsing and falling out of trees or just prior to death. It is the only obvious behavioural indication that birds are ill. Neck drooping is also reported in healthy birds under hot conditions.

13.3.2. Meloxicam - An Alternative

- Meloxicam is a second generation NSAID and rated better than Diclofenac for the treatment of livestock, with reduced risk of side effects, and is also approved for human use in more than 70 countries. Meloxicam is licensed as a veterinary drug in India, Europe and USA.

13.3.3. Banned but still in use

- The Indian Government in May 2006 banned the veterinary use of diclofenac. Unfortunately, the ban didn't reach far enough and human forms of diclofenac were used to treat sick cattle.
- One particular problem is that the human form of diclofenac is much cheaper than alternative drugs like meloxicam which have been safety tested for vultures

13.3.4. Significance of vultures in India

- Scavenging on animal carcasses of animals and thereby helping keep the environment clean;
- Disposal of dead bodies as per the religious practices of the Parsi community.
- Vultures are the primary removers of carrion in India and Africa.

13.3.5. Without vultures

- Equilibrium between populations of other scavenging species will be affected.
- Result in increase in putrefying carcasses.
- Movement of Feral dogs into carcass dumps increasing the spread of diseases such as rabies, anthrax.
- Traditional custom of the Parsis of placing their dead in the 'Towers of Silence' for vultures to feed upon will be affected.
- Life will be much harder for local hide and bone-collectors, who rely on cleaned carcasses in order to earn a living.
- Cattle owners will have to pay to have livestock carcasses buried or burnt.

Do you know?

Although all snakes can swim, sea snakes live mostly in the water. They do need to come up for air but can stay under water for up to an hour!

13.3.6. Vulture Safety Zones

- The concept of a VSZ is unique for the Asian continent but similar VSZ are in operation in both Europe and Africa.
- Aim of developing VSZs is to establish targeted awareness activities surrounding 150 km radius of vultures' colonies so that no diclofenac or the veterinary toxic drugs are found in cattle carcasses, the main food of vultures(to provide safe food).
- The VSZ is spread around in several hundred kilometers covering the Jim Corbett in Uttarakhand, Dudhwa and Kartarniaghat forest reserves in UP which is adjoining the Indo-Nepal border. Nepal has already set up VSZ on the Indian borders.

Do you know?

- Frog bones form a ring when the frog is hibernating, just like trees do. Scientists can use these rings to figure out the age of a frog.
- Frogs don't drink water they absorb it through their skin.

13.3.7. VSZ's provide:

- A safe source of food that is free of contamination from veterinary drugs, poisons and other agricultural chemicals.
- A place where vultures can feed free from human disturbances.
- Supplement the ever decreasing food base for vultures.
- Extra food close to breeding colonies, this helps to increase their breeding success by improving the survival chances of the young vultures.
- Additional food, such as bone fragments, which can be supplied to breeding birds.
- An economical and practical way of disposing of old and unproductive cattle.
- Help to reduce the risk of spreading diseases.
- A place for scientists to study the biology and ecology of these threatened species.
- An opportunity to raise public awareness on vulture conservation and to raise funds.
- An excellent opportunity for eco-tourists to observe these magnificent birds.

13.3.8. Zones

1. The zone between Uttarkhand to Nepal, which spans from Corbett to Katriya Ghat, a Tarai belt, covering 30,000 square kilometers will be earmarked as Vulture Safe zone. Slender-billed vulture and white-backed vulture are found in this area, which is marshy grassland, savannas and forests.
2. Similarly, a belt between Dibrugarh in Assam to North Lakhimpur in Arunachal Pradesh will also be conserved as a vulture safe zone where slender-billed and white-backed species of vultures are found.
3. The third zone would be in central India, covering Chhatisgarh, where white-backed and long-billed vultures are found.

13.3.9. What have to be done?

- Diclofenac free zones' (DFZ) meant the complete removal of diclofenac in the identified vulture safe zones i.e. places where vulture colonies have been identified.

13.3.10. Vulture Restaurants

- At this restaurant, tables are reserved only for the unique and rare vultures by Maharashtra and Punjab forest departments

Aim

- Conserve the fast dwindling vulture population.
- As uncontaminated food shortage is one of the reasons for vultures' decline, these scavengers will be fed by serving diclofenac free carcasses of cattle through restaurants.
- VR includes involvement of local communities in in-situ conservation, is having dual benefits to vultures and to our society.
- People inform the forest department in case of the death of an animal in their village and the department tests the dead animal for the presence of diclofenac.
- In their absence the department pays monetary benefits to the owner of the animal and informer, transports it to the vulture restaurant.
- Apart from this, whenever a vulture nesting is found, conservation measures like providing safe food near nesting trees, constant protection from all sorts of disturbances, etc., are put in place without delay.

Benefits

- Conservation of vulture from extinction
- Community participation in conservation
- Economic incentive to local cattle breeders
- Phasing out the use of diclofenac
- Awareness
- Dining spots

- Punjab - Kathlore, Chandola and Chamraur
- Maharastra – Gadchiroli, Thane, Nagpur, Nashik, Raigad districts

13.3.11.Breeding Centres in India

- Vulture Breeding and Conservation Centre had already been established at Pinjore, Haryana in 2001, and Rani, Guwahati (Assam) and another one has been established at Buxa, West Bengal in 2005. The Central Zoo Authority of India has also committed for supporting 4 such centers in the zoos at Junagadh, Bhopal, Hyderabad and Bhubhaneshwar in 2006-07.
- The Ministry of Environment and Forests (MoEF) & BNHS has taken up a program to release 30 young vultures from the breeding centre's to the demarcated safe zones at three places by year 2014.
- Though the breeding facilities had started some years back, it takes time for the reproduction amongst vultures. Young vultures take at least four to five years to fly.

Do you know?

India has more than 100,000 brick kilns and they are noxious sources of pollution, particularly soot.

13.3.12.Measures taken to Conserve Vultures

- The veterinary drug Diclofenac has been banned by Indian and Nepalese governments.
- Meloxicam, a safe alternative for vultures and other scavenging birds, is being promoted as an effective replacement.
- VSZ
- Vulture Restaurant sites.
- Captive breeding centers have been established to secure healthy birds from the wild for breeding in captivity for purposes of conservation and future release.
- Awareness raising activities targeting various groups such as veterinarians, pharmacists, school children, government agencies, conservation partners and local communities are being organized regularly.

13.3.13.India'S Role in Conservation

- India moved a motion in IUCN in 2004 for vulture conservation, which was accepted in the form of the IUCN resolution which called upon Gyps vulture Range countries to begin action to prevent all uses of diclofenac in veterinary applications, and establishment of IUCN South Asian Task Force under the auspices of the IUCN and range countries to develop and implement national vulture recovery plans, including conservation breeding and release."

13.3.14.Save - Saving Asia's Vultures From Extinction.

- It's a consortium of like-minded, regional and international organizations, created to oversee and co-ordinate conservation, campaigning and fundraising activities to help the plight of south Asia's vultures.

To save three species of Gyps vulture

- Oriental white-backed vulture or White-rumped vulture
- Long-billed vulture
- Slender-billed vulture

Partners

- Bird Conservation Nepal, Bombay Natural History Society (India), International Centre for Birds of Prey (UK), National Trust for Nature Conservation (Nepal),, Royal Society for the Protection of Birds (UK)

13.4. ONE HORN RHINO

13.4.1. Indian Rhino Vision 2020

- Indian rhino vision 2020 implemented by the department of environment and forests, Assam with The Bodo autonomous council as a active partner. The programme will be supported by WWF – India, WWF areas (Asian rhino and elephant action strategy) programme, the international rhino foundation (IRF), save the rhino's campaign of zoological institutions worldwide and a number of local NGOs.
- The vision of this program is to increase the total rhino foundation in Assam from about 2000 to 3000 by the year 2020 and to ensure that these rhinos are distributed over at least 7 protected areas (PA) to provide long term viability of the one-horned rhino population.

Do you know?

Woolly rhino (Coelodonta antiquitatis), probably the most well known of the extinct rhinos.

13.4.2. Why?

- Concentrating so many rhinos in a single protected area like Kaziranga exposes the species to risks of calamities (epidemics, floods, massive poaching attempts). Further, rhinos in Pabitora have exceeded carrying capacity and numbers must be reduced to protect the habitat and to mitigate the increasing rhino-human conflicts.
- Rhino species: Greater one-horned rhino (Rhinoceros unicornis)
- Activities: Anti-poaching, monitoring, translocations, community conservation.
- Translocations are the backbone of the IRV 2020 program
- The goal set was to populate the potential rhino habitat areas identified viz. Manas NP, Dibru Saikhowa WLS, Laokhowa - Bura Chapori WLS with a viable population of rhino through translocations from Kaziranga NP and Pobitora WLS.
- Manas National Park was selected as the first site for translocation of rhinos.
- Ten rhinos have been released into Manas since 2008. Ten more rhinos will be moved from Kaziranga National Park before the end of the year. Translocating rhinos will help to create a viable population of this threatened species.

Do you know?

CNG is not without environmental drawbacks, burning CNG has the highest rates of potentially hazardous carbonyl emissions. - Central Pollution Control Board (study 2011).

13.5. PROJECT SNOW LEOPARD

- SNOW LEOPARD: The mystical apex predator
- The snow leopard is a globally endangered species. Merely 7,500 are estimated to be surviving over two million square kilometers in the Himalaya and Central Asian mountains, where they are facing tremendous human pressures.
- India is perhaps home to 10% of the global population in less than 5% of its global range, thus having a substantial proportion of its global population.
- Distribution in India – in Indian Himalayas, high altitude areas located above the forests (alpine meadows and cold deserts) Areas above 3000m broadly constitute snow leopard range in India. In the five Himalayan states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh.
- Most snow leopard occurring in China, followed by Mongolia and India. India is believed to have between 400 and 700 snow leopards in the five Himalayan states, though these estimates are not precise.
- Threats posed due to
  - competition with livestock,
  - degradation,
  - poaching, and
  - even facing local extinction

Do you know?

Chinese experts have successfully used a plant Pteris vittata L (The Chinese fern) to clean arsenic pollution from the soil.

13.5.1. Project Snow Leopard - Jan 2009

- The Project Snow Leopard is an Indian initiative for strengthening wildlife conservation in the Himalayan high altitudes.

Aim:

- to promote a knowledge-based and adaptive conservation framework that fully involves the local communities, who share the snow leopard's range, in conservation efforts.

Goal:

- To safeguard and conserve India's unique natural heritage of high altitude wildlife populations and their habitats by promoting conservation through participatory policies and actions.

Location:

- All biologically important landscapes in the Himalayan high altitudes in the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, and Arunachal Pradesh.
- Project Snow Leopard is designed for all biologically important habitats within the snow leopard's range, irrespective of their ownership (e.g. Protected Areas, common land, etc.).
- Forming an estimated 1,29,000 km^2 within India, these areas generally comprise the non-forested or sparsely-forested high altitude regions of the

Himalaya and Trans-Himalaya above elevations of 3,000 m in the Western Himalaya and above 4,000m in the eastern Himalaya.

13.5.2. Why to conserve the high altitude ecosystem?

- The high altitudes of India (> 3000 m. to 130,000 km², including the Himalaya and Trans-Himalaya biogeographic zones) support a unique wildlife assemblage of global conservation importance.
- This includes highly endangered populations of species such as the snow leopard, two species of bears, wolf, red panda, mountain ungulates such as the wild yak, chiru, Tibetan gazelle, Tibetan argali, Ladakh urial, two species of musk deer, the hangul, three species of goral, serow, and takin, etc. High altitude lakes and bogs provide breeding grounds for a variety of avifauna including the black-necked crane, barheaded Geese, brahminy ducks, and brown-headed gulls, etc.
- India has ratified international agreements promoting the conservation of high altitude wildlife species such as the snow leopard.
- In 2003, the Convention on Migratory Species included the snow leopard as a Concerted Action Species under its Appendix I.
- Similarly, in 2003, the Convention on International Trade in Endangered Species (CITES) expanded the scope of the CITES Tiger Enforcement Task Force to include all Asian big cat species including the snow leopard.
- In both cases, representatives of the MoEF played a vital role in elevating the conservation prominence of the snow leopard internationally.
- Each state will select one biologically important site and develop a science-based, participatory conservation programme in that site in the first five years of Project Snow Leopard. This will be subsequently expanded to include other biologically important sites.

13.6. SEA TURTLE PROJECT

- A significant proportion of world's Olive Ridley Turtle population migrates every winter to Indian coastal waters for nesting mainly at eastern coast.
- With the objective of conservation of olive ridley turtles and other endangered marine turtles, Ministry of Environment & Forests initiated the Sea Turtle Conservation Project in collaboration of UNDP in November, 1999 with Wildlife Institute of India, Dehradun as the Implementing Agency.
- The project is being implemented in 10 coastal States of the country with special emphasis in State of Orissa.
- The project has helped in preparation of inventory map of breeding sites of Sea Turtles, identification of nesting and breeding habitats along the shore line, and migratory routes taken by Sea Turtles, development of guidelines to safeguard and minimize turtle mortality, development of national and international cooperative and collaborative action for Sea Turtle Conservation, developing guideline plans for tourism in sea turtle areas and developing infrastructure and human resources for Sea Turtle Conservation.
- One of the important achievements have been demonstration of use of Satellite Telemetry to locate the migratory route of Olive Ridley Turtles in the sea and sensitizing the fishermen and State Government for the use of Turtle Exclusion Device (TED) in fishing trawlers to check turtle mortality in fishing net.

Do you know?

Hippopotamuses are found in Africa. The name hippopotamus means 'river horse' and is often shortened to hippo.

13.7. INDIAN CROCODILE CONSERVATION PROJECT

- The Indian Crocodile Conservation Project has pulled back the once threatened crocodilians from the brink of extinction and place them on a good path of recovery. The Project has not just produced a large number of crocodiles, but has contributed towards conservation in a number of related fields as well.

Objectives:

- To protect the remaining population of crocodilians in their natural habitat by creating sanctuaries.
- To rebuild natural population quickly through 'grow and release' or 'rear and release' technique - more than seven thousand crocodiles have been restocked - about 4000 gharial (Gavialis gangeticus), 1800 mugger (Crocodylus palustris) and 1500 salt-water crocodiles (Crocodylus porosus)

- To promote captive breeding,
- To take-up research to improve management.
- To build up a level of trained personnel for better continuity of the project through training imparted at project-sites and through the (erstwhile) Central Crocodile Breeding and Management Training Institute, Hyderabad.
- To involve the local people in the project intimately

13.8. PROJECT HANGUL

- The Kashmir stag (Cervus affinis hanglu) also called Hangul is a subspecies of Central Asian Red Deer native to northern India.
- It is the state animal of jammu & kasmir
- This deer lives in groups of two to 18 individuals in dense riverine forests, high valleys, and mountains of the Kashmir valley and northern Chamba in Himachal Pradesh.
- In Kashmir, it's found in Dachigam National Park at elevations of 3,035 meters.
- These deer once numbered from about 5,000 animals in the beginning of the 20th century. Unfortunately, they were threatened, due to habitat destruction, over-grazing by domestic livestock and poaching.
- This dwindled to as low as 150 animals by 1970. However, the state of Jammu & Kashmir, along with the IUCN and the WWF prepared a project for the protection of these animals. It became known as Project Hangul. This brought great results and the population increased to over 340 by 1980.

Do you know?

Hippopotamuses are threatened by habitat loss and poachers who hunt them for their meat and teeth.

13.9. CAPTIVE BREEDING

- Captive breeding means that members of a wild species are captured, then bred and raised in a special facility under the care of wildlife biologists and other expert.
- Bringing an animal into captivity may represent the last chance to preserve a species in the wild in these situations:
- When a population drops dangerously, captive breeding can boost numbers. Captive-produced young can sometimes be released into the wild where populations have diminished or disappeared, yet where suitable habitat remains to support them.
- When all of the existing habitat is poor quality or other environmental problems occur, a captive population can be maintained until the problems can be solved or another appropriate habitat can be found for the animal in the wild.
- When the existing habitat is fragmented, captive breeding combined with management may provide the only hope for survival by providing opportunities for genetic mixing.
- When a group of birds stays in one area of degraded habitat because they are behaviorally trapped, captive breeding and release programs can help them to expand their range.
- By holding and breeding birds in captivity we acquire knowledge about them that may be difficult or impossible to accomplish in the wild. Sometimes this scientific research provides some of the information necessary to save a species.
- If situation demands reintroduction or reestablishment in the natural habitat may also arise.
- E.g. captive breeding of lion tailed macaque in Arignar Anna Zoological Park, Chennai and in mysore zoo.

13.10. GANGES DOLPHIN

- The Ministry of Environment and Forests notified the Ganges River Dolphin as the National Aquatic Animal.
- The River Dolphin inhabits the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of Nepal, India, and Bangladesh.
- It is estimated that their total population is around 2,000 and they are listed in Schedule I of the Wildlife Protection Act (1972).
- The Ganges Dolphin is among the four "obligate" freshwater dolphins found in the world – the other three are the 'baiji' found in the Yangtze River (China), the 'bhulan' of the Indus (Pakistan) and the 'boto' of the Amazon River (Latin America).
- Although there are several species of marine dolphins whose ranges include some freshwater habitats, these four species live only in rivers and lakes.

- The Chinese River Dolphin was declared functionally extinct by a team of international scientists in 2006.
- In India, the Ganges River Dolphin is threatened by river water pollution and siltation, accidental entanglement in fishing nets and poaching for their oil.
- In addition, alterations to the rivers in the form of barrages and dams are separating populations. Various organizations, including the WWF-India in Uttar Pradesh have initiated programs for conservation and re-introduction of the River Dolphin.

13.11. SCHEDULE LIST-WPA, 1972

- WPA 1972 consists of 6 schedule lists, which give varying degrees of protection.
- Poaching, smuggling and illegal trade of animals listed Schedule 1 to schedule 4 are prohibited. Animals listed in schedule 1 and part II of schedule 2 have absolute protection - offences under these are prescribed the highest penalties. Examples of animals listed in schedule 1 are lion tailed macaque, rhinoceros, great indian bustard, narcondam hornbill, nicobar megapode, black buck, etc. Examples of animals listed in schedule 2 are rhesus macaque, dhole, Bengal porcupine, king cobra, flying squirrel, himalyan brown bear, etc.
- Animals listed in schedule 3 and schedule 4 are also protected, but the penalties are lower compared to schedule 1 and part 2 of schedule 2. Examples of animals listed in schedule 3 are hyaena, hogdeer, nilgai, goral, sponges, barking deer, etc. Examples of animals listed in schedule 4 are mangooses, vultures, etc.
- Animals listed in schedule 5 are called "vermin" which can be hunted. Mice, rat, common crow and flying fox (fruit eating bats) are the list of animals (only 4 nos) in schedule 5 [i.e. vermin].
- Cultivation, Collection, extraction, trade, etc. of Plants and its derivatives listed in schedule 6 are prohibited. Red Vanda, blue Vanda, kuth, pitcher plant, beddomes cycad and ladies slipper orchid are the list of plants listed in schedule 6. [a detailed description of the schedule 6 plants have been given in 10.6 of this book]

Do you know?

Nothing specified in wildlife protection act 1972, shall affect the hunting rights conferred on the Scheduled Tribes of the Nicobar Islands in the Union territory of Andaman and Nicobar Islands.

◆◆◆◆◆◆

PART - III

CHAPTER - 14

CLIMATE CHANGE

Climate is the long-term average of a region's weather events. The Earth's climate is not static. Over the billions of years of earth's existence, it has changed many times in response to natural causes like sun spot, ice age glaciations, etc.

"Climate change" means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

However, when today people talk about 'climate change', they mean the changes in climate over the last 100 years which is caused predominantly by human activity.

The phrase 'climate change' represents a change in the long-term weather patterns. Climate change is not a change of weather in a particular day; it is the cumulative change of long term weather pattern i.e. changes in climate. For example, it's possible that a winter day in Jammu, could be sunny and mild, but the average weather, the climate, tells us that Jammu's winters will mainly be cold and include snow and rain. The change in the pattern of Jammu's winters from the normal winter pattern represents an epitome of climate change.

Climate change is the measurable effects of the continual warming trend. Climate change is usually measured in major shifts in temperature, rainfall, snow, and wind patterns lasting decades or more.

Humans are creating climate change by burning large amounts of fossil fuels (coal, oil, natural gas), deforestation (when forests are cut down or burned, they can no longer store carbon, and the carbon is released to the atmosphere).

14.1. GLOBAL WARMING

Earth has warmed at an unprecedented rate over the last hundred years and particularly over the last two decades. Since 1992, each year has been one of the 20 warmest years on record. 2010 was the hottest year on record, worldwide. An upsurge in the amount of extreme weather events, such as wildfires, heat waves, and strong tropical storms, is also attributed

"Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities."

14.1.1. Global Warming - Impacts

- Rise in Sea level
- Changes in rainfall patterns.
- Increased likelihood of extreme events such as heat wave, flooding, hurricanes, etc.
- Melting of the ice caps.
- Melting of glaciers.
- Widespread vanishing of animal populations due to habitat loss.
- Spread of disease (like malaria, etc).
- Bleaching of Coral Reefs.
- Loss of Plankton due to warming of seas.

Do you know?

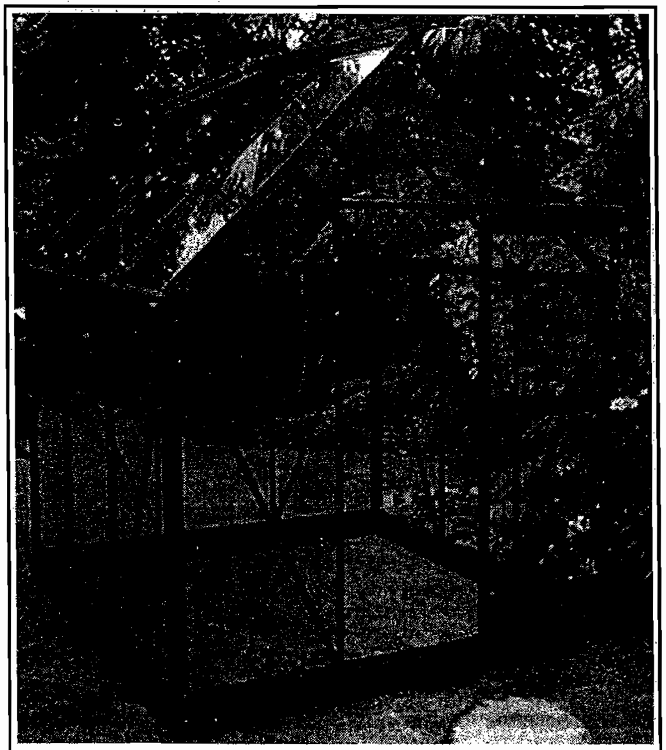
Black Panther is not a separate species. Blackness, the general darkering of colour is due to the excessive presence of a substance called Melanin which intensifies pigmentation. The production of melanin is increased where there is a combination of high temperature, humidity and reduced light. Both black and normal-coloured cubs may be produced in the same litter.

14.2. GREENHOUSE EFFECT

The greenhouse effect is a naturally occurring phenomenon that blankets the earth lower atmosphere and warms it, maintaining the temperature suitable for living things to survive.

Just as greenhouses, that keeps the air warm inside its chamber, water vapor and green house gases warms the Earth. Greenhouse gases play an important role in the balance of Earth's cooling and warming.

According to one estimate, in the absence of naturally occurring green house effect, the average temperature of the earth surface would be -190 C instead of present value of 150C and the earth would be a frozen lifeless planet.



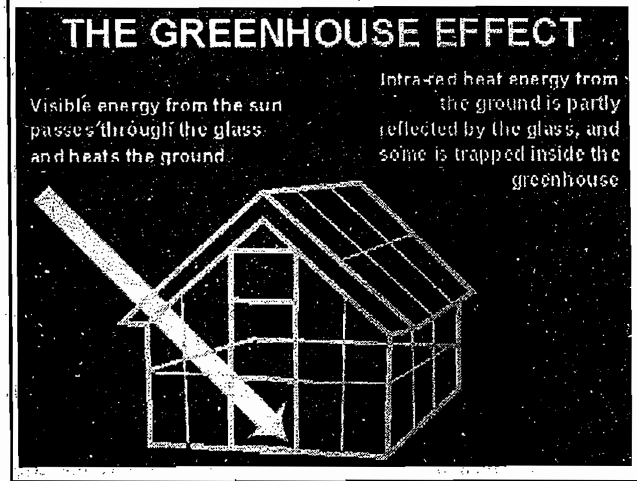
Green House

A greenhouse/ glasshouse is a building made of glass chambers in which plants are grown in cold countries or in cold climate areas. There is a continued increase in temperature in green house even when the outside temperature remained low. It protects plants from frost.

Do you know?

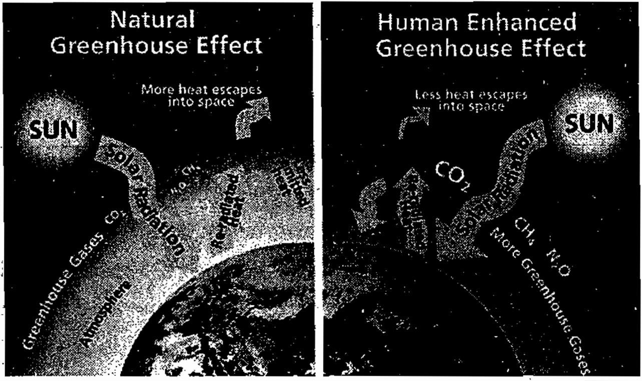
- Tree rings provide precise information about environmental events, including volcanic eruptions.

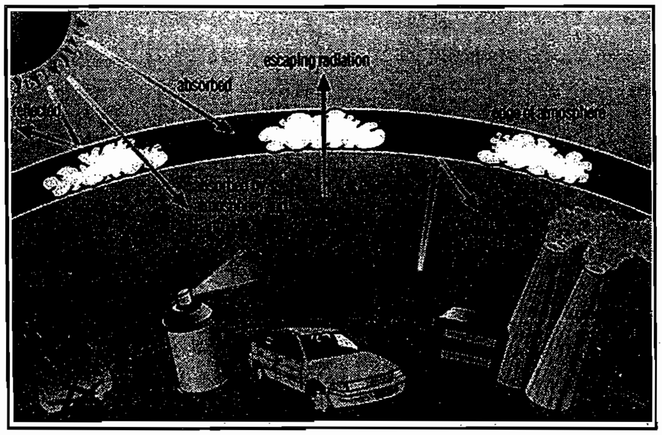
14.2.1. What is the Greenhouse Effect?


THE GREENHOUSE EFFECT
Visible energy from the sun passes through the glass and heats the ground.
Infra-red heat energy from the ground is partly reflected by the glass, and some is trapped inside the greenhouse

The greenhouse effect is a process (similar to green house) caused by greenhouse gases, which occur naturally in the atmosphere. This process plays a crucial role in warming the Earth's surface, making it habitable.

However, human-generated greenhouse gas emissions upset the natural balance and lead to increased warmth.


Natural Greenhouse Effect
More heat escapes into space
SUN
Solar Radiation
Greenhouse Gases
Atmosphere
Human Enhanced Greenhouse Effect
Less heat escapes into space
SUN
CO2
Solar Radiation
CH4 N2O
More Greenhouse Gases


escaping radiation
absorbed
reflected
edge of atmosphere

Incoming Energy

- The Sun emits energy that is transmitted to Earth. Because the Sun is very hot, the energy is emitted in high-energy short wavelengths that penetrate the Earth's atmosphere.

Absorption

- About 30% of the Sun's energy is reflected directly back into space by the atmosphere, clouds, and surface of the Earth. The rest of the Sun's energy is absorbed into the Earth's system.

Emission

- The Earth re-emits energy back into the atmosphere. Because the Earth is cooler than the Sun, the energy is emitted in the form of infrared radiation, at wavelengths longer than the incoming solar energy.

Role of Greenhouse Gases

- Greenhouse gases in the atmosphere absorb much of the long-wave energy (infrared radiation) emitted from the Earth's surface, preventing it from escaping from the Earth's system. The greenhouse gases then re-emit this energy in all directions, warming the Earth's surface and lower atmosphere.

Human Role

- The atmospheric concentration of greenhouse gases has increased significantly over the past two centuries, largely due to human-generated carbon dioxide emissions from burning fossil fuels, deforestation.
- This increase has amplified the natural greenhouse effect by trapping more of the energy emitted by the Earth. This change causes Earth's surface temperature to increase.

Do you know?

- No tree dies of old age. They are generally killed by insects, disease or by people.
- Trees grow from the top, not from the bottom as is commonly believed.
- Tree leaves help trap and remove tiny particles of soot and dust which otherwise damages human lungs.
- Tree root networks filter contaminants in soils producing clean water.
- Trees prevent erosion by trapping soil that would otherwise become silt

14.3. GREEN HOUSE GASES

- Greenhouse gases" means those gaseous constituents of the atmosphere, both natural and anthropogenic, those absorbs and re-emit infrared radiation.

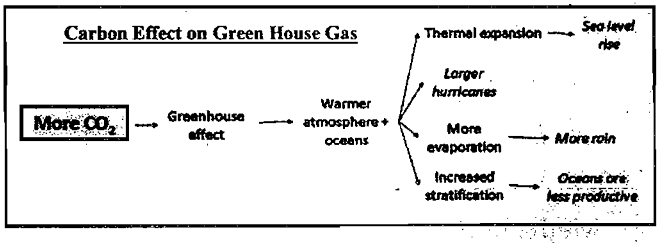
14.3.1. WATER VAPOUR

Water vapour is the biggest overall contributor to the greenhouse effect and humans are not directly responsible for emitting this gas in quantities sufficient to change its concentration in the atmosphere. However, CO2 and other greenhouse gases is increasing the amount of water vapour in the air by boosting the rate of evaporation.

Unlike CO2, which can persist in the air for centuries, water vapour cycles through the atmosphere quickly, evaporating from the oceans and elsewhere before coming back down as rain or snow.

Since the rate of evaporation rises with temperature, the amount of water vapour in the air at any one time (and the amount of warming it causes) is strongly related to the amount of other greenhouse gases in the air.

14.3.2. CARBON DIOXIDE



- Carbon dioxide (CO_2) is the primary greenhouse gas emitted through human activities. Carbon dioxide is naturally present in the atmosphere as part of the Earth's carbon cycle (the natural circulation of carbon among the atmosphere, oceans, soil, plants, and animals).
- Human activities are altering the carbon cycle both by adding more CO_2 to the atmosphere and by reducing the ability of natural sinks, like forests, to remove CO_2 from the atmosphere.
- While CO_2 emissions come from a variety of natural sources, human-related emissions are responsible for the increase that has occurred in the atmosphere since the industrial revolution.

The main sources

i. The combustion of fossil fuels to generate electricity.

ii. The combustion of fossil fuels such as gasoline and diesel used for transportation.

iii. Many industrial processes emit CO2 through fossil fuel combustion.

iv. Several processes also produce CO2 emissions through chemical reactions that do not involve combustion, for example, the production and consumption of mineral products such as cement, the production of metals such as iron and steel, and the production of chemicals, etc.

Emissions and Trends

- Changes in CO2 emissions from fossil fuel combustion are influenced by many factors, including population growth, economic growth, changing energy prices, new technologies, changing behavior, and seasonal temperatures.
- Between 1990 and 2010, the increase in CO2 emissions corresponded with increased energy use by an expanding economy and population.

Reducing Carbon Dioxide Emissions

- The most effective way to reduce carbon dioxide (CO2) emissions is to reduce fossil fuel consumption. Other strategies include Energy Efficiency, Energy Conservation, Carbon Capture and Sequestration.

Do you know?

The pesticide industry in India, which is the fourth largest in the world and second largest in the Asia-Pacific region, only after China.

14.3.3. METHANE

- Methane (CH4) is emitted by natural sources such as wetlands, as well as human activities such as leakage from natural gas systems and the raising of livestock.
- Natural processes in soil and chemical reactions in the atmosphere help remove CH4 from the atmosphere.

Source

Natural sources:

- Wetlands are the largest source, emitting CH4 from bacteria that decompose organic materials in the absence of oxygen.
- Smaller sources include termites, oceans, sediments, volcanoes, and wildfires.

Human induced:

- Agriculture: Domestic livestock such as cattle, buffalo, sheep, goats, and camels produce large amounts of CH4 as part of their normal digestive process. Also, when animals' manure is stored or managed in lagoons or holding tanks, CH4 is produced. Because humans raise these animals for food, the emissions are considered human-related. Globally, the Agriculture sector is the primary source of CH4 emissions
- Industry: Methane is the primary component of natural gas. Some amount of CH4 is emitted to the atmosphere during the production, processing, storage, transmission, and distribution of crude oil & natural gas.
- Waste from Homes and Businesses: Methane is generated in landfills as waste decomposes and from the treatment of wastewater.

Do you know?

Polar bears are the largest living carnivorous quadruped (animals with four legs).

14.3.4. NITROUS OXIDE

- Nitrous oxide (N2O) is naturally present in the atmosphere as part of the Earth's nitrogen cycle, and has a variety of natural sources.
- However, human activities such as agriculture, fossil fuel combustion, wastewater management, and industrial processes are increasing the amount of N2O in the atmosphere.

Sources

Natural sources:

- Natural emissions of N2O are mainly from bacteria breaking down nitrogen in soils and the oceans.

Human induced:

- Agriculture. Nitrous oxide is emitted when people add nitrogen to the soil through the use of synthetic fertilizers. Nitrous oxide is also emitted during the breakdown of nitrogen in livestock manure and urine, which contributed to 6% of N2O emissions in 2010.
- Transportation. Nitrous oxide is emitted when transportation fuels are burned.
- Industry. Nitrous oxide is generated as a byproduct during the production of nitric acid, which is used to make synthetic commercial fertilizer, and in the production of adipic acid, which is used to make fibers, like nylon, and other synthetic products.
- Removal: Nitrous oxide is removed from the atmosphere when it is absorbed by certain types of bacteria or destroyed by ultraviolet radiation or chemical reactions.

Do you know?

Telecoeras, a single-horned, hippo-like grazer, once common in North America.

14.3.5. FLUORINATED GASES

- They are emitted through a variety of industrial processes such as aluminum and semiconductor manufacturing & Substitution for Ozone-Depleting Substances.
- Many fluorinated gases have very high global warming potentials (GWPs) relative to other greenhouse gases. Fluorinated gases are well-mixed in the atmosphere, spreading around the world after they're emitted.
- Fluorinated gases are removed from the atmosphere only when they are destroyed by sunlight in the far upper atmosphere. In general, fluorinated gases are the most potent and longest lasting type of greenhouse gases emitted by human activities.
- There are three main categories of fluorinated gases—
  1. hydrofluorocarbons (HFCs),
  2. perfluorocarbons (PFCs), and
  3. sulfur hexafluoride (SF6).

Substitution for Ozone-Depleting Substances:

- Hydrofluorocarbons are used as refrigerants, aerosol propellants, solvents, and fire retardants. These chemicals were developed as a replacement for chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) because they do not deplete the stratospheric ozone layer.
- Unfortunately, HFCs are potent greenhouse gases with long atmospheric lifetimes and high GWPs, and they are released into the atmosphere through leaks, servicing, and disposal of equipment in which they are used.

Industry:

- Perfluorocarbons are compounds produced as a by-product of various industrial processes associated with aluminum production and the manufacturing of semiconductors.
- Like HFCs, PFCs generally have long atmospheric lifetimes and high GWPs.
- Sulfur hexafluoride is used in magnesium processing and semiconductor manufacturing, as well as a tracer gas for leak detection. HFC-23 is produced as a by-product of HCFC-22 production.

Transmission and Distribution of Electricity:

- Sulfur hexafluoride is used in electrical transmission equipment, including circuit breakers.

Do you know?

Planting trees on denuded and waste land, along roads, railway tracks, deserted areas, watersheds, etc. protects soil from erosion by wind or water by firmly binding it with roots and by diverting runoff during rains

14.3.6. BLACK CARBON

- Black carbon (BC) is a solid particle or aerosol, (though not a gas) contributes to warming of the atmosphere.
- Black carbon, commonly known as soot, is a form of particulate air pollutant, produced from incomplete combustion. It consists of pure carbon in several linked forms.

Source

- biomass burning,
- cooking with solid fuels, and
- diesel exhaust,etc.

What does BC do?

- Black carbon warms the Earth by absorbing heat in the atmosphere and by reducing albedo, (the ability to reflect sunlight) when deposited on snow and ice.
- BC is the strongest absorber of sunlight and heats the air directly. In addition, it darkens snow packs and glaciers through deposition and leads to melting of ice and snow.
- Regionally, BC disrupts cloudiness and monsoon rainfall and accelerates melting of mountain glaciers such as the Hindu Kush-Himalayan glaciers.

Life time

- Black carbon stays in the atmosphere for only several days to weeks.
- Thus the effects of BC on the atmospheric warming and glacier retreat disappear within months of reducing emissions.

How far India contributes to globe?

- According to estimates, between 25 and 35 percent of black carbon in the global atmosphere comes from China and India, emitted from the burning of wood and cow dung in household cooking and through the use of coal to heat homes.

Government Measures

- Project Surya has been launched to reduce black carbon in atmosphere by introducing efficient stove technologies, solar cookers, solar lamps and biogas plants.

14.3.7. Brown Carbon

- Brown carbon is a ubiquitous and unidentified component of organic aerosol which has recently come into the forefront of atmospheric research.
- Light-absorbing organic matter (other than soot) in atmospheric aerosols of various origins, e.g., soil humics, humic-like substances (HULIS), tarry materials from combustion, bioaerosols, etc.

Possible Sources of Brown Carbon are

- Biomass burning (possibly domestic wood burning) is shown to be a major source of brown carbon
- smoke from agricultural fires may be an additional source.
- "Brown carbon" is generally referred for greenhouse gases and "black carbon" for particles resulting from impure combustion, such as soot and dust.

Do you know?

A flowering tree usually has a dome-shaped appearance and a deliquescent stem in which the main trunk divides at some distance from the ground into several branches, which branch again and again, making the trunk appear to deliquese or melt away

14.4. CLIMATE FORCINGS

- Climate "forcings" are factors in the climate system that either increase or decrease the effects to the climate system.
- Positive forcings such as excess greenhouse gases warm the earth while negative forcings, such as the effects of most aerosols and volcanic eruptions, actually cool the earth.
- Atmospheric aerosols include volcanic dust, soot from the combustion of fossil fuels, particles from burning forests and mineral dust.
- Dark carbon-rich particles such as soot from diesel engines absorb sunlight and warm the atmosphere.
- Conversely, exhaust from high-sulphur coal or oil produce light aerosols that reflect sunlight back to space, producing a cooling effect. Aerosols that form naturally during volcanic eruptions cool the atmosphere. Large volcanic eruptions can eject enough ash into the atmosphere to lower temperature for a year or more until the sulfate particles settle out of the atmosphere.

14.4.1. Forcing

Altering the Energy Balance

- The power of a process to alter the climate is estimated by its "radiative forcing," the change in the Earth's energy balance due to that process.
- Some climate forcings are positive, causing globally averaged warming, and some are negative, causing cooling. Some, such as from increased CO_2 concentration, are well known; others, such as from aerosols, are more uncertain.

Natural Forcings

- Natural forcings include changes in the amount of energy emitted by the Sun, very slow variations in Earth's orbit, and volcanic eruptions.
- Since the start of the industrial revolution, the only natural forcing with any long-term significance has been a small increase in solar energy reaching Earth. However, this change is not nearly enough to account for the current warming.

Human-Induced Forcings

- Climate forcing can also be caused by human activities. These activities include greenhouse gas and aerosol emissions from burning fossil fuels and modifications of the land surface, such as deforestation.

Human-Generated Greenhouse Gases

- Greenhouse gases are a positive climate forcing; that is, they have a warming effect. Carbon dioxide emitted from the burning of fossil fuel is presently the largest single climate forcing agent, accounting for more than half of the total positive forcing since 1750.

Human-Generated Aerosols

- Burning fossil fuels adds aerosols to the atmosphere. Aerosols are tiny particles in the atmosphere composed of many things, including water, ice, ash, mineral dust, or acidic droplets.
- Aerosols can deflect the Sun's energy and impact the formation and lifetime of clouds. Aerosols are a negative forcing; that is, they have a cooling effect.

Causes of Climate Change

- While natural forcings do exist, they are not significant enough to explain the recent global warming. Human activities are very likely responsible for most of the recent warming.

How to estimate the effect of each gas?

- Each gas's effect on climate change depends on three main factors:

1. How much of these gases are in the atmosphere?
   - Concentration, or abundance, is the amount of a particular gas in the air. Greenhouse gas concentrations are measured in parts per million, parts per billion, and even parts per trillion.
   - One part per million is equivalent to one drop of water diluted into about 13 gallons of liquid (roughly the fuel tank of a compact car).
2. How long do they stay in the atmosphere?
   - Each of these gases can remain in the atmosphere for different amounts of time, ranging from a few years to thousands of years.
   - All of these gases remain in the atmosphere long enough to become well mixed, meaning that the amount that is measured in the atmosphere is roughly the same all over the world, regardless of the source of the emissions.
3. How strongly do they impact global temperatures?
   - Some gases are more effective than others at making the planet warmer and "thickening the Earth's blanket (green house gas)".
   - For each greenhouse gases, a Global Warming Potential (GWP) has been calculated to reflect how long it remains in the atmosphere, on average, and how strongly it absorbs energy.

14.5. GLOBAL WARMING POTENTIAL

- Global warming potential describes the impact of each gas on global warming.
- The two most important characteristics of a GHG in terms of climate impact are how well the gas absorbs energy (preventing it from immediately escaping to space), and how long the gas stays in the atmosphere.
- The Global Warming Potential (GWP) for a gas is a measure of the total energy that a gas absorbs over a particular period of time (usually 100 years), compared to carbon dioxide.
- Gases with a higher GWP absorb more energy, per pound, than gases with a lower GWP, and thus contribute more to warming Earth.

GWP & Lifetime of Green House Gases:

S. No	GAS	GWP (100-year)	LIFETIME (years)
1	Carbon di oxide	1	50-200
2	Methane	21	12
3	Nitrous oxide	310	120
4	Hydro fluoro carbons (HFCs)	140-11,700	1-270
5	Perfluoro carbons (PFCs)	6,500-9,200	800-50,000
6	Sulfur hexafluoride (SF6)	23,900	3,200

Carbon dioxide (CO2) has a GWP of 1 and serves as a baseline for other GWP values.

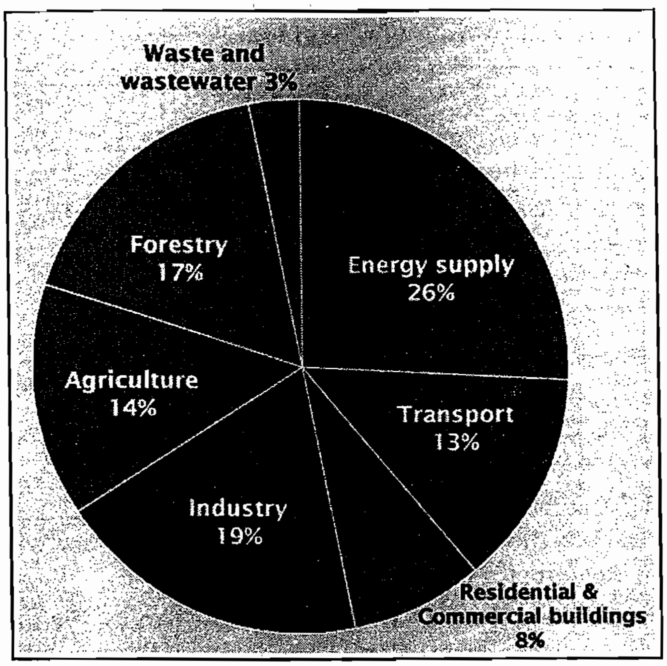
- The larger the GWP, the more warming the gas causes. For example, methane's 100-year GWP is 21, which means that methane will cause 21 times as much warming as an equivalent mass of carbon dioxide over a 100-year time period.
- Methane (CH4) has a GWP more than 20 times higher than CO2 for a 100-year time scale. CH4 emitted today lasts for only 12 years in the atmosphere, on average. However, on a pound-for-pound basis, CH4 absorbs more energy than CO2, making its GWP higher.
- Nitrous Oxide (N2O) has a GWP 300 times that of CO2 for a 100-year timescale. N2O emitted today remains in the atmosphere for an average of 120 years.
- Chloro fluoro carbons (CFCs), hydro fluoro carbons (HFCs), hydro chloro fluoro carbons (HCFCs), perfluoro carbons (PFCs), and sulfur hexafluoride (SF6) are called high-GWP gases because, for a given amount of mass, they trap substantially more heat than CO2.

Do you know?

Spices and condiments are flavoring agents obtained from plants. Because they have little nutritive value, they are not classified as foods. They contain essential oils, which impart flavor and aroma to food and add greatly to the pleasure of eating. They stimulate the appetite and increase the flow of gastric juices.

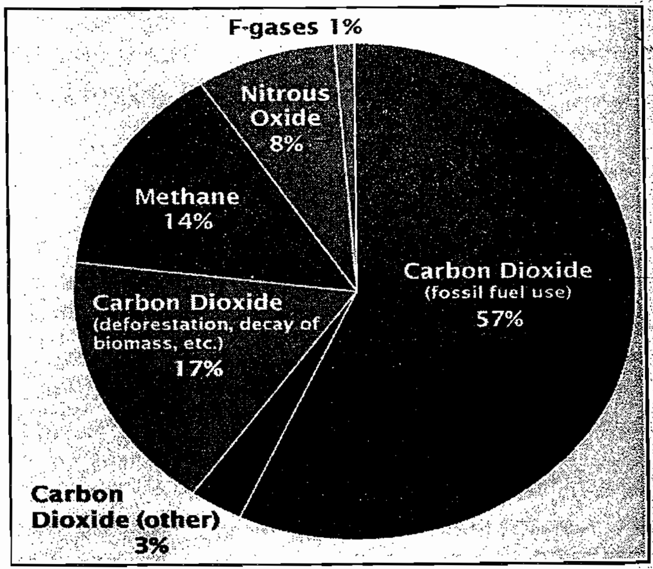
14.6. GLOBAL EMISSIONS

14.6.1. GLOBAL EMISSIONS BY SOURCE



- Energy Supply (26% of 2004 global greenhouse gas emissions) - The burning of coal, natural gas, and oil for electricity and heat is the largest single source of global greenhouse gas emissions.
- Industry (19% of 2004 global greenhouse gas emissions) - Greenhouse gas emissions from industry primarily involve fossil fuels burned on-site at facilities for energy. also includes emissions from chemical, metallurgical, and mineral transformation processes not associated with energy consumption.
- Land Use, Land-Use Change, and Forestry (17% of 2004 global greenhouse gas emissions) - Greenhouse gas emissions from this sector primarily include carbon dioxide (CO_2) emissions from deforestation, land clearing for agriculture, and fires or decay of peat soils. This estimate does not include the CO_2 that ecosystems remove from the atmosphere.
- Agriculture (14% of 2004 GHG emissions) - global greenhouse gas emissions) - Greenhouse gas emissions from agriculture mostly come from the management of agricultural soils, livestock, rice production, and biomass burning.
- Transportation (13% of 2004 global greenhouse gas emissions) - Greenhouse gas emissions from this sector primarily involve fossil fuels burned for road, rail, air, and marine transportation. Almost all (95%) of the world's transportation energy comes from petroleum-based fuels, largely gasoline and diesel.
- Commercial and Residential Buildings (8% of 2004 global greenhouse gas emissions) - Greenhouse gas emissions from this sector arise from on-site energy generation and burning fuels for heat in buildings or cooking in homes.
- Waste and Wastewater (3% of 2004 global greenhouse gas emissions) - The largest source of greenhouse gas emissions in this sector is landfill methane (CH_4), followed by wastewater methane (CH_4) and nitrous oxide (N_2O). Incineration of some waste products that were made with fossil fuels, such as plastics and synthetic textiles, also results in minor emissions of CO_2.

14.6.2. BY GAS



Do you know?

Shola forest is an evergreen ecosystem found at the high altitude regions. It is distributed in Nilgris and Palani hills of Tamil Nadu, Kerala and Karnataka. Sholas are found at sites where adjacent slope converges. These are interrupted by grasslands ecosystem with stunted evergreen woods and confined to sheltered valleys, gleeves, hallows and depressions. The main role of shola forest is conservation of water in that region. It needs well drained soils and avoids swampy soils.

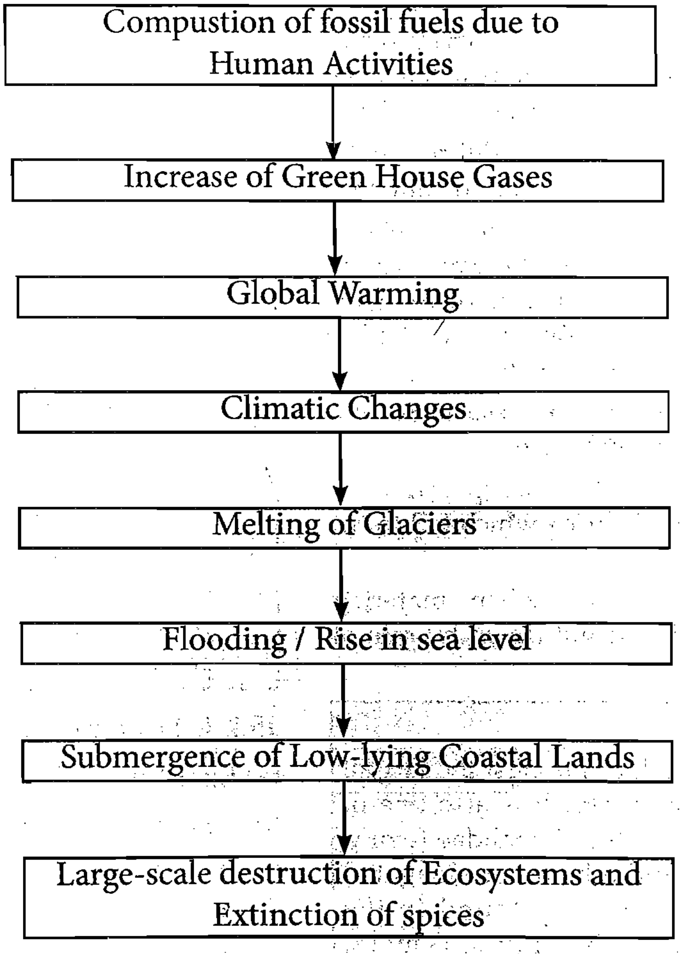
14.7. RECEDING GLACIERS-A SYMPTOM OF GLOBAL CLIMATE CHANGE

- 150 years ago there were 147 glaciers in Glacier National park, but today only 37 glaciers remain, and scientists predict that they are likely to melt by the year 2030. Similarly, glaciers all across the Himalayas and Alps are retreating and disappearing every year. There are almost 160,000 glaciers found in Polar Regions and high mountain environments. Therefore, researchers are increasingly using satellite remote sensors to routinely survey our world's glaciers in a fraction of the time.

14.7.1. Impact of glacial retreat

- The retreat of glaciers in the Andes and the Himalayas will have a potential impact on water supplies.
- Climate change may cause variations in both temperature and snowfall, causing changes in mass balance of a glacier.
- The Himalayas and other mountain chains of central Asia support large regions that are glaciated. These glaciers provide critical water supplies to dry countries such as Mongolia, western China, Pakistan and Afghanistan. The loss of these glaciers would have a tremendous impact on the ecosystem of the region.
- World's leading scientists predict that global warming may pose serious threat to national and global economy and the environment.
- The poor and low-lying countries that will find it difficult to cope with the damages caused by changing climate and rise in sea level

14.7.2. Chain of events


Compustion of fossil fuels due to Human Activities
Increase of Green House Gases
Global Warming
Climatic Changes
Melting of Glaciers
Flooding / Rise in sea level
Submergence of Low-lying Coastal Lands
Large-scale destruction of Ecosystems and Extinction of spices

◆◆◆◆◆

CHAPTER - 15

ACIDIFICATION

Acid rain is the rainfall that has been acidified. It is formed when oxides of sulfur and nitrogen react with the moisture in the atmosphere. It is rain with a pH of less than 5.6. Acid rain is particularly damaging to lakes, streams, and forests and the plants and animals that live in these ecosystems.

15.1. TYPES OF ACID DEPOSITION

"Acid rain" is a broad term referring to a mixture of wet and dry deposition (form of deposition material) from the atmosphere

(a) Wet Deposition

- If the acid chemicals in the air are blown into areas where the weather is wet, the acids can fall to the ground in the form of rain, snow, fog, or mist.
- As this acidic water flows over and through the ground, it affects a variety of plants and animals.
- The strength of the effects depends on several factors, including how acidic the water is; the chemistry and buffering capacity of the soils involved; and the types of fish, trees, and other living things that rely on the water.
- Precipitation removes gases and particles from the atmosphere by two processes :
  - (i) rain-out which is the incorporation of particles into cloud drops which fall to the ground, and
  - (ii) washout which occurs when materials below the cloud is swept down by rain or snow it falls.

Do you know?

Gharial crocodile counts amongst the largest crocodile species in the world. It is also one of two surviving members of the Gavialidae family. Gharial Crocodiles of India have an elongated and narrow snout. It is mainly found in the river systems of Indus, Brahmaputra, Ganges, Mahanadi, Kaladan and Ayeyarwady

(b) Dry Deposition

- In areas where the weather is dry, the acid chemicals may become incorporated into dust or smoke and fall to the ground through dry deposition, sticking to the ground, buildings, vegetation, cars, etc.
- Dry deposited gases and particles can be washed from these surfaces by rainstorms, through runoff.
- This runoff water makes the resulting mixture more acidic.
- About half of the acidity in the atmosphere falls back to earth through dry deposition.

The pH scale

- The pH scale is a measure of how acidic or basic (alkaline) a solution is.
- It ranges from 0 to 14. A pH of 7 is neutral.
- A pH less than 7 is acidic, and a pH greater than 7 is basic.
- It was devised in 1909 and it is a logarithmic index for the hydrogen ion concentration in an aqueous solution.
- pH values decreases as hydrogen ion levels increases.
- A solution with pH 4 is ten times more acidic than solution with pH 5, and a hundred times more acidic than solution with pH 6.
- Whilst the pH range is usually given as 0 to 14, lower and higher values are theoretically possible.

15.1.1. Sources of compounds causing acid rain

(a) Sulphur

(i) Natural sources:

- seas and oceans,
- volcanic eruptions,
- Biological processes in the soil e.g., Decomposition of organic matter.

(ii) Man-made sources:

- burning of coal (60% of SO2) and
- petroleum products (30% of SO2), and
- The smelting of metal sulfide ores to obtain the pure metals.
- Industrial production of Sulfuric acid in metallurgical, chemical and fertilizer industries.

(b) Nitrogen

Natural sources:

- lightening,
- volcanic eruption, and
- Biological activity.

Anthropogenic sources:

- Forest fires
- Combustion of oil, coal, and gas

(c) Formic acid

- Biomass burning due to forest fires causes emission of formic acid (HCOOH) and formaldehyde (HCHO) into the atmosphere.
- Large fraction formaldehyde gets photo – oxidation and forms formic acid in the atmosphere.

These are three main compounds that cause acidification of rain in the atmosphere.

(d) Other Acids:

- Chlorine
- Phosphoric acid
- Hydrochloric acid (smokestacks).
- Carbon monoxide and carbon dioxide (automobiles). These become carbonic acid.

Does it occurs only in industrial areas alone?

SOX and NOX that create Acid Rain are often transported to distances far away from their points of origin by the wind so that the adverse effects of pollution are also experienced at place remote from the place of genesis. The problem is further compounded as the environmental damage caused by acid rain is not uniform, but is area-specific.

15.1.2. Common characteristics of acid rain areas:

Areas which are prone to acid-rain attacks have some common characteristics :

- ➢ They are concentrated in the industrialized belt of the northern hemisphere.
- ➢ They are often upland and / or mountainous areas, which are well-watered by rain and snow.
- ➢ Due to the abundance of water, they possess numerous lakes and streams and also have more land covered with vegetation.
- ➢ Being upland, they often have thin soils and glaciated bedrock.

Do you know?

The banana tree (plant) has only a thick false stem (pseudostem), which is not woody but made up of a central core of soft tissues concealed by the fibrous and sheathing bases of large leaves. Strictly speaking, the banana plant is a giant herb.

World scenario

Many parts of Scandinavia, Canada, the North and Northeast United States and Northern Europe (particularly West Germany and upland Britain) share these features. Across the Atlantic there are number of acid rain hot spots including Nova Scotia, Southern Ontario and Quebec in Canada, the Adirondack Mountains in New York, Great Smoky mountains, parts of Wisconsin, Minnesota, and the Colorado Rockies of the US.

In India

In India, the first report of acid rain came from Bombay in 1974. Instances of acid rain are being reported from metropolitan cities.

In India, the annual SO2 emission has almost doubled in the last decade due to increased fossil fuel consumption. Lowering of soil pH is reported from north-eastern India, coastal Karnataka and Kerala, parts of Orissa, West Bengal and Bihar.

Indicators

Lichens serve as good bio-indicators for air pollution. In the variety of pH around 6.0, several animals, those are important food items for fish decline. These include the freshwater shrimp, crayfish, snails and some small mussels.

15.1.3. Chemistry of Acid Rain

Six basic steps are involved in the formation of acid rain:

1. The atmosphere receives oxides of sulfur and nitrogen from natural and man-made sources.
2. Some of these oxides fall back directly to the ground as dry deposition, either close to the place of origin or some distance away.

3. Sunlight stimulates the formation of photo-oxidants (such as ozone) in the atmosphere.
4. These photo-oxidants interact with the oxides of sulfur and nitrogen to produce H_2SO_4 and HNO_3 by oxidation.
5. The oxides are of sulfur and nitrogen, photo-oxidants, and other gases (like NH_3)
6. Acid rain containing ions of sulfate, nitrate, ammonium and hydrogen falls as wet deposition.

Difference between normally and anthropogenically acidified lakes

Naturally acidic lakes	Anthropogenically acidified lakes
Brown to yellow colour caused by humic substances	Very clear water caused by reduced primary productivity
Concentrations of dissolved organic carbon are high while transparency is low	Dissolved organic carbon concentrations are low. Whereas the transparency is high.
Low pH but well buffered.	Poorly buffered
Abound with aquatic life.	Some of the more sensitive taxa, such as blue-green algae, some bacteria, snails, mussels crustaceans, mayflies and fish either decrease or / are eliminated.

Do you know?

The Indian giant squirrel is a large-bodied diurnal, arboreal, and herbivorous squirrel. The species is endemic to deciduous, mixed deciduous, and moist evergreen forests of peninsular India, reaching as far north as the Satpura hill range of Madhya Pradesh. IUCN Status – least concern.

15.1.4. Impact Of Acid Rain

(a) Soil

- The exchange between hydrogen ions and the nutrient cations like potassium and magnesium in the soil cause leaching of the nutrients, making the soil infertile.
- This is accompanied by a decrease in the respiration of soil organisms.
- An increase in ammonia in the soil due to a decrease in other nutrients decreases the rate of decomposition.
- The nitrate level of the soil is also found to decrease.
- The impact of acid rain on soil is less in India; because Indian soils are mostly alkaline, with good buffering ability.

(b) Vegetation

Acid rains affect trees and undergrowth in forest in several ways, causing reduced growth or abnormal growth:

➢ The typical growth-decreasing symptoms are:

- Discoloration and loss of foliar biomass
- Loss of feeder-root biomass, especially in conifers
- Premature senescence (aging) of older needles in conifers
- Increase in susceptibility of damage to secondary root and foliar pathogens
- Death of herbaceous vegetation beneath affected trees
- Prodigious production of lichens on affected trees.
- Death of affected trees.

(c) Micro organisms

- pH determines the proliferation of any microbial species in a particular environment and the rate at which it can produce.
- The optimum pH of most bacteria and protozoa is near neutrality; most fungi prefer an acidic environment, most blue-green bacteria prefer an alkaline environment.
- So after a long run of acid rain, microbial species in the soil and water shift from bacteria-bound to fungi-bound and cause an imbalance in the microflora.
- This causes a delay in the decomposition of soil organic material, and an increase in fungal disease in aquatic life and forests.

(d) Wild life

The effects of acid rain on wild life are not very obvious and are therefore, difficult to document. Nevertheless, several direct and indirect effects of acid rain on the productivity and survival of wildlife populations have been reported.

- Acid rain can directly affect the eggs and tadpoles of frogs and salamanders that breed in small forest ponds.

- It has been postulated that acid rain can indirectly affect wildlife by allowing metals bound on soils and sediments to be released into the aquatic environment, where toxic substances may be ingested by animals, like birds, that feed in such an environment.
- Other indirect effects of acid rain on wildlife are loss or alteration of food and habitat resources.

(e) Humans

Acid rain affects human health is a number of ways.

- The obvious ones are bad smells, reduced visibility; irritation of the skin, eyes and the respiratory tract.
- Some direct effects include chronic bronchitis, pulmonary emphysema and cancer.
- Some indirect effects include food poisoning vis a vis drinking water and food.
- An increase in the levels of toxic heavy-metals like manganese, copper, cadmium and aluminium also contribute to the detrimental effects on human health.

Do you know?

- ➢ Bonsai—i.e., tailored or human-made miniature or dwarfed living trees that have been prevented from reaching their normal size—are grown in pots and kept in greenhouses, drawing rooms, etc. This technique was first perfected by the Japanese.
- ➢ Bamboos are trees without a main trunk but with a cluster of culms arising from the underground rhizome. These culms are unbranched, with distinct nodes and internodes that give them a jointed appearance.
- ➢ Trees reduce oxides of carbon in the air, can also fix atmospheric nitrogen, disintegrate waste and act as sinks of pollution
- ➢ Sometimes seeds of a plant are formed without fertilization. This phenomenon is called "agamospermy," a kind of parthenogenesis. A fruit that matures without seed formation is called "parthenocarpic fruit."
- ➢ Beverage plants are those plants which yield beverages or drinks—nonalcoholic or alcoholic—that are palatable and refreshing. Nonalcoholic beverages usually contain caffeine, an alkaloid, which has stimulating and refreshing qualities. Alcoholic beverages are those that contain one or more hydroxyl (–OH) groups; e.g., ethanol

(f) Acid rain damage on Materials

Material	Type of Impact	Principal Air Pollutants
Metals	Corrosion, tarnishing	Sulphur Oxides and other acid gases
Building stone	Surface erosion soiling, black crust formation	Sulphur Oxides and other acid gases
Ceramics and glass	Surface erosion, surface crust formation	Acid gases, especially fluoride-containing
Paints and organic coatings	Surface erosion, discolouration, soiling	Sulphur dioxides, hydrogen sulphide
Paper	Embrittlement, discolouration	Sulphur Oxides
Photographic Materials	Micro-blemishes	Sulphur Oxides
Textiles	Fading, colour change	Nitrogen oxides, ozone
Leather	Weakening, powdered surface	Sulphur oxides
Rubber	Cracking	Ozone

(g) Socio-economic impacts of acid rain :

The adverse impact of acid rain on farming and fishing leads to the deterioration of life quality indices like GNP and per capita income, especially in the predominantly agricultural and developing countries like India

15.1.5. Trigger Effect of Acid Rain on Pollutants:

A low pH of the rainwater and subsequent increased acidity in the environment can trigger off or aggravate the effects of certain harmful pollutants.

(i) Mercury:

- Methyl mercury and related short chain alkyl mercurial compounds are most dangerous to humans, as they accumulate in edible fish tissue.
- Although acid deposition may not increase the production of methyl mercury, it may increase the partitioning of methyl mercury into the water column.
- The use of lime has helped in reducing the mercury levels in fish.

(ii) Aluminium:

- Acidified waters are known to leach substantial amounts of aluminium from watersheds.
- Even at relatively low levels, aluminium has been implicated in dialysis dementia, a disorder of the central nervous system, which may be toxic to individuals with impaired kidney function.

(iii) Cadmium:

- Cadmium can enter the drinking water supply through corrosion of galvanized pipe or from the copper-zinc through corrosion of galvanized piper or from the copper-zinc solder used in the distribution systems.
- A decrease in water pH from 6.5 to 4.5 can result in a fivefold increase in cadmium and could cause renal tubular damage.

(iv) Lead:

- Foetuses and infants are highly susceptible to drinking water lead contamination.
- High blood lead levels in children (>30 mug/Ml) are believed to induce biochemical and neurophysiological dysfunction.
- However, lower than normal blood levels of lead can cause mental deficiencies and behavioural problems.

(v) Asbestos:

Asbestos in natural rock can be released by acidic waters.

Do you know?

Tree ferns like Cyathaea and Alsophila have erect rhizomes with generally unbranched trunks, topped by a crown of graceful, feathery fronds that form a rosette at the apex.

15.1.5. Control Measures :

Reducing or eliminating the sources of pollution by

- ➢ Buffering- the practice of adding a neutralizing agent to the acidified water to increase the pH is one of the important control measures. Usually lime in the form of calcium oxide and calcium carbonate is used.
- ➢ Reducing the emission of SO2 from power stations by burning less fossil fuel, using alternate energy sources like tidal, wind, hydropower etc.,
- ➢ using low sulphur fuel;
- ➢ desulphurization
- ➢ decreasing emission of NOx from power stations and
- ➢ Modification of engines.
- ➢ Emissions of SOx can be controlled by
  - Converting to sulphuric acid.
  - Converting it to elemental sulphur.
  - Neutralizing it and using it in the manufacture of other products.

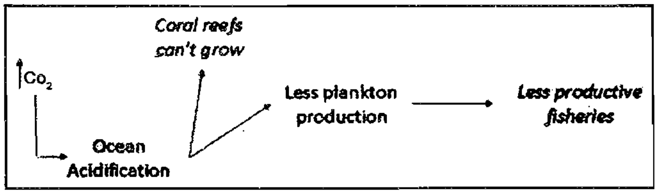
15.2. OCEAN ACIDIFICATION

Oceans are an important reservoir for CO_2, absorbing a significant quantity of it (one-third) produced by anthropogenic activities and effectively buffering climate change.

Ocean acidification is the change in ocean chemistry - lowering of ocean pH (i.e. increase in concentration of hydrogen ions) driven by the uptake of carbon compounds by the ocean from the atmosphere.

As the uptake of atmospheric carbon dioxide by the ocean increases, the concentration of hydrogen ions in the ocean increases, the concentration of carbonate ions decreases, the pH of the oceans decreases and the oceans become less alkaline – this process is know as ocean acidification.

15.2.1. CO_2 effect on ocean acidification



The uptake of atmospheric carbon dioxide is occurring at a rate exceeding the natural buffering capacity of the ocean.

The pH of the ocean surface waters has decreased by about 0.1 pH unit (i.e. 26% increase in ocean hydrogen ion concentration) since the beginning of the industrial revolution.

The ocean currently has a pH around 8.0 and is therefore 'basic' and it is nearly impossible, chemically, for all of it to actually become a pH less than 7.0. Why do we therefore refer to 'ocean acidification'?

That is because acidification is the direction of travel, the trend, regardless of the starting point. Acidification refers to lowering pH from any starting point to any end point on the pH scale.

Forms of calcium carbonate

Calcite and aragonite are two different forms of calcium carbonate.

1. Calcite is the mineral form found in the shells of planktonic algae, amoeboid protists, some corals, echinoderms, and some molluscs (e.g. oysters); it is relatively less soluble.
2. Aragonite is a more soluble form of calcium carbonate; it is found in most corals, most mollusks (small planktonic snails), as well as some species of algae.

15.2.2. Influence of other factors

Various factors can locally influence the chemical reactions of CO2 with sea water and add to the effects to ocean acidification. For example,

i. Acid rain

Acid rain can have a pH between 1 and 6 and has impact on surface ocean chemistry. It has major effect on ocean acidification locally and regionally but very small globally.

ii. Eutrophication

Coastal waters are also affected by excess nutrient inputs, mostly nitrogen, from agriculture, fertilizers and sewage. The resulting eutrophication leads to large plankton blooms, and when these blooms collapse and sink to the sea bed the subsequent respiration of bacteria decomposing the algae leads to a decrease in sea water oxygen and an increase in CO_2 (a decline in pH).

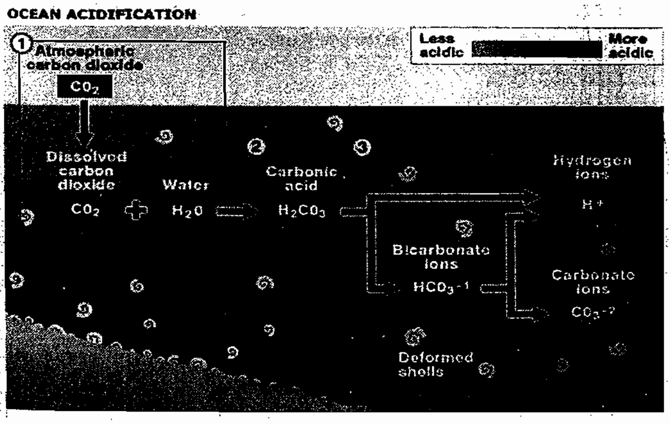
How it reacts?

The term 'ocean acidification' summarizes several processes that occur when CO_2 reacts with sea water.

Two reactions are particularly important. Firstly, the formation of carbonic acid with subsequent release of hydrogen ions:

$$CO_2 \quad + \quad H_2O \quad H_2CO_3 \rightleftharpoons H+ \quad \rightleftharpoons HCO_3\text{--}$$

(Carbon dioxide) + (Water) (Carbonic acid) (Hydrogen ions) + (Bicarbonate ions)



The above reaction and release of hydrogen ions increases acidity and thus pH level is reduced.

A second reaction, between carbonate ions, CO2 and water produces bicarbonate ions.

The combined effect of both these reactions not only increases acidity but also lowers the availability of carbonate ions.

15.2.3. Effect of ocean acidification

Seawater absorbs CO_2 to produce carbonic acid (H_2CO_3), bicarbonate (HCO_3--) and carbonate ions (CO_{32}-).

These carbonate ions are essential to the calcification process that allows certain marine organisms to build their calcium carbonate shells and skeletons (e.g. hard tropical corals, cold water corals, molluscs, crustaceans, sea urchins, certain types of plankton, lobsters, etc).

However, increases in atmospheric CO_2 levels lead to decrease in pH level, increase in the concentration of carbonic acid and bicarbonate ions, causing a decrease in the concentration of carbonate ions.

Thus carbonate ions are less available and calcification is therefore harder to achieve, and may be prevented altogether. Imagine trying to build a house while someone keeps stealing your bricks.

This impact of ocean acidification may therefore have potentially catastrophic consequences for ocean life and many marine species of economic importance.

15.2.4. Mitigation

- Reducing CO_2
- promoting government policies to cap CO_2 emissions,
- eliminate offshore drilling,
- by advocating for energy efficiency and
- Alternative energy sources such as wind power, solar, etc.

15.2.5. Saturation horizons

- Deep, cold ocean waters are naturally undersaturated with carbonate ions causing the shells of most calcifying organisms to dissolve.
- Surface waters are oversaturated with carbonate ions and do not readily dissolve shells of calcifying organisms.
- The saturation horizon is the level below which calcium carbonate minerals undergo dissolution.

- Those organisms that can survive below the saturation horizon do so due to special mechanisms to protect their calcium carbonate from dissolving.
- As ocean acidification causes this horizon to rise vertically in the water column so more and more calcifying organisms will be exposed to undersaturated water and thus vulnerable to dissolution of their shells and skeletons.
- The saturation horizon of calcite occurs at a greater ocean depth than that for aragonite, but both horizons have moved closer to the surface presently when compared to the 1800s.

Do you know?

Chameleons are seen inhabiting almost all the parts of south India and west of the Ganges. However, they are rarely seen in areas that receive heavy rainfall. Chameleons are mostly arboreal and are found in trees or on smaller bushes.

15.2.6. Ocean acidification and the short and long-term fate of carbon in the system

On long timescales (>100,000 years) there is a natural balance maintained between the up-take and release of CO2 on Earth; the CO2 produced by volcanoes, the main natural source of CO2, is taken up by the production of organic matter by plants and by rock weathering on land.

However, rock weathering takes tens of thousands of years so will not remove the current anthropogenic input of CO2 to the atmosphere and ocean fast enough.

On shorter time scales (>1,000 years), the ocean has an internal stabilizing feedback linking the ocean carbon cycle to the underlying carbonate rich sediment known as carbonate compensation.

The upper layers of the ocean tend to be supersaturated with CaCO3 so little dissolution takes place, whilst the deep ocean is undersaturated and carbonate readily dissolves.

The first boundary between these two states is known as the lysocline, the depth at which dissolution strongly increases in the deep ocean.

The CaCO3 in the form of dead shells sink to the sea bed. If it is of shallow water depth, the majority is buried in the sediment and trapped for a long time, but where the shells sink in deep water nearly all the $CaCO_3$ is dissolved, thereby not locking the carbon away for millions of years.

The current increased rate of dissolution of atmospheric CO_2 into the ocean results in an imbalance in the carbonate compensation depth (CCD), the depth at which all carbonate is dissolved.

As the pH of the ocean falls, it results in a shallowing of the lysocline and the CCD, thus exposing more of the shells trapped in the sediments to understaturated conditions causing them to dissolve, which will help buffer ocean acidification but over a long time scale of a thousand years.

UPWELLING

- Surface Coastal regions periodically experience upwelling events where deeper ocean water circulates onto continental shelves and near-shore areas.
- This exposes the productive upper ocean ecosystems to colder water containing more nutrients & more CO_2.
- As ocean acidification makes the upper oversaturated layer of sea water shallower each year, these natural upwelling events will more often cause undersaturated water to well up and flow to the shore.
- Coastal marine organisms that form shells are unaccustomed to such events, and periodic exposures to these significantly different conditions may affect these communities.

15.2.7. Winners and losers

- The growth and level of photosynthesis of certain marine phytoplankton and plant species may increase with higher CO_2 levels, but this is by no means a general rule.
- For others, higher CO_2 and rising acidity may have either negative or neutral effects on their physiology.
- Therefore, particular marine plants will be 'winners', while others will be 'losers' and some may show no signs of change but change is inevitable.

A reduction in atmospheric CO_2 levels is essential to halt ocean acidification before it is too late.

◆ ◆ ◆

CHAPTER - 16

OZONE HOLE

Ozone is a natural gas; it is an allotrope of oxygen consisting of three atoms of oxygen bound together in a non-linear fashion. The chemical symbol of ozone is O3.

It is found in two different layers of the atmosphere. Ozone in the troposphere is "bad" because it dirties the air and helps to form smog, which is not good to breathe. Ozone in the stratosphere is "good" because it protects life on Earth by absorbing some of the sun's harmful Ultra Violet (UV) rays.

The ozone layer is very important because the configuration of the ozone molecule and its chemical properties are such that ozone efficiently absorbs ultraviolet light, thus acting like a sun-screen.

> The UV rays cause direct damage to the genetic material or DNA of animal and plant cells. Exposure of mammals to UV light has been shown to act on the immune system, thereby making the body more susceptible to diseases.

In doing so, ozone protects oxygen at lower altitudes from being broken up by the action of ultraviolet light and also keeps most of the ultraviolet radiation from reaching the earth's surface.

It helps in reducing the risks of mutation and harm to plant and animal life. Too much UV rays can cause skin cancer and will also harm all plants and animals. Life on Earth could not exist without the protective shield of the ozone layer.

Do you know?

- Hoolock Gibbon is the only ape found in India. Rest of the monkeys are all macaques and langurs. In India is distributed in the northeast India.
- Palms are typically unbranched trees with only one trunk (columnar stem), called the "caudex," which ends in a crown of large leaves.

16.1. OZONE HOLE

16.1.1. Change in equilibrium

- The equilibrium between the formation and destruction of ozone, has been upset by the influx of several substances into the atmosphere which react with ozone and destroy it.
- The rate at which ozone is being destroyed is much faster than the rate at which it is being formed.
- It implies that there is a significant decrease in the concentration of ozone in a particular region of the atmosphere, hence the name 'ozone hole'.
- The best example of such an ozone hole is the atmosphere over the Antarctic which has only about 50 percent of the ozone that originally occurred there. The actual realization of ozone-depletion came only in 1985.

16.1.2. Sources

chlorofluorocarbons (CFCs):

CFCs molecules are made up of chlorine, fluorine and carbon.

Where it is used?

They are used as refrigerants, propellents in aerosol sprays, foaming agents in plastic manufacturing, fire extinguishing agents, solvents for cleaning electronic and metallic components, for freezing foods etc .

Two-thirds of CFC is used as refrigerants while one-third is used as blowing agents in foam insulation products.

Why CFCs are used?

CFCs has a wide and varied application due to its properties like non-corrosiveness, non-inflammability, low toxicity and chemical stability, etc.

Lifetime & removal of CFCs

Unlike other chemicals, CFCs cannot be eliminated from the atmosphere by the usual scavenging processes like photodissociation, rain-out and oxidation.

In fact, the residence time of CFCs in the atmosphere estimated to be between 40 and 150 years. During this period, the CFCs move upwards by random diffusion, from the troposphere to the stratosphere.

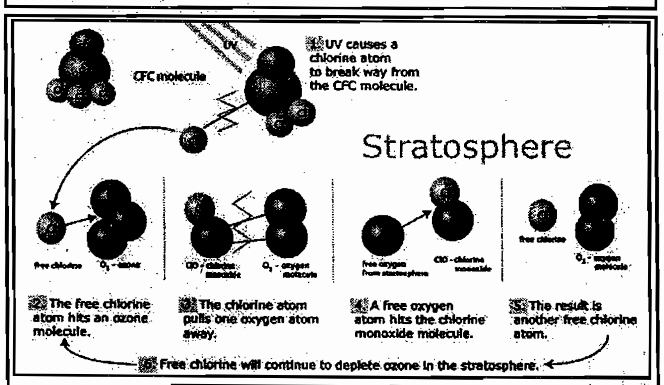
The escape of CFCs

The CFCs enter into the atmosphere by gradual evaporation from their source. CFCs can escape into the atmosphere from a discarded refrigerator. Since the CFCs are thermally stable they can survive in the troposphere. But in the stratosphere, they are exposed to UV radiation.

The chemical reaction

The molecules of CFCs when exposed to UV radiation break up, thus freeing chlorine atoms. A free chlorine atom reacts with an ozone molecule to form chlorine monoxide (ClO). The molecules of chlorine monoxide further combine with an atom of oxygen. This reaction results in the formation of an oxygen molecule (O_2) and reformation of the free chlorine atom (Cl).

Chlorine +	→	Chlorine monoxide + oxygen
Chlorine monoxide + monoxide (o)	→	Chlorine + Oxygen
Net reaction :		
ozone + monoxide (o)	→	oxygen + oxygen


UV
CFC molecule
1. UV causes a chlorine atom to break way from the CFC molecule.
Stratosphere
free chlorine
O_3 - ozone
ClO - chlorine monoxide
O_2 - oxygen molecule
free oxygen from stratosphere
ClO - chlorine monoxide
free chlorine
O_2 - oxygen molecule
2. The free chlorine atom hits an ozone molecule.
3. The chlorine atom pulls one oxygen atom away.
4. A free oxygen atom hits the chlorine monoxide molecule.
5. The result is another free chlorine atom.
6. Free chlorine will continue to deplete ozone in the stratosphere.

CFC Ozone Depletion

The depletion of O3 is catalystic. The element that destroys O3 (i.e chlorine) is being reformed at the end of cycle. A single chlorine atom destroys thousands of ozone molecules before encountering reactive nitrogen or hydrogen compounds that eventually return chlorine to its reservoirs.

Do you know?

Barking deer/common muntjac is the mammal with the lowest recorded chromosome number. It gives calls similar to barking, usually on sensing a predator. Status – least threatened.

CFC substitutes – characteristics

- The substitute for CFCs should be safe, low cost, increased energy efficiency of CFC replacement technology, effective refrigerants with low ozone layer depletion potential (ODP) and low global warming potential (GWP).
- CFC-12 (R-12) is a widely used refrigerant. HFC 134a (R-134a) is the most promising alternative (R-143a) and (R-152a) can also be used.

16.1.4. Nitrogen Oxides :

Source

The sources of nitrogen oxides are mainly explosions of thermonuclear weapons, industrial emissions and agricultural fertilizers.

The chemical reaction

Nitric oxide (NO) catalytically destroys ozone.

Nitric oxide + ozone	→	Nitrogen dioxide + Oxygen
Nitrogen dioxide + monoxide	→	Nitric oxide + Oxygen

The escape of N_2O

Nitrous oxide (N_2O) is released from solid through denitrification of nitrates under anaerobic conditions and nitrification of ammonia under aerobic conditions. This N_2O can gradually reach the middle of the stratosphere, where it is photolytically destroyed to yield nitric oxide which in turn destroys ozone.

Other substances:

Bromine containing compounds called halons and HBFCs, i.e. hydrobromo fluorocarbons [both used in fire extinguishers and methyl bromide (a widely used pesticide)]. Each bromine atom destroys hundred times of more ozone molecules than what a chlorine atom does.

Bromine + ozone	→	Bromine monoxide + Oxygen
Bromine monoxide + chlorine monoxide	→	Oxygen + Bromine + chlorine

Bromine (Br) combines with ozone forming bromine monoxide (BrO) and Oxygen (O2). The BrO further reacts with chlorine monoxide (ClO) to give oxygen (O2) and free atoms of bromine (Br) and chlorine (Cl). This free atoms can further react with ozone.

Sulphuric acid particles: These particles free chlorine from molecular reservoirs, and convert reactive nitrogen into inert forms thus preventing the formation of chlorine reservoirs.

Carbon tetrachloride (a cheap, highly toxic solvent) and methyl chloroform (used as a cleaning solvent for clothes and metals, and a propellant in a wide range of consumer products, such as correction fluid, dry cleaning sprays, spray adhesives) and other aerosols.

Monitoring the Ozone Layer

- Some organizations that help in monitoring the atmosphere and form a network of informations communication about the atmosphere, including ozone layer monitoring are:
- World Meteorological Organization (WMO)
- World Weather Watch (WWW)
- Integrated Global Ocean Services Systems (IGOSS)
- Global Climate Observing System (GCOS)

16.1.5. Role of polar stratospheric clouds in ozone depletion.

There are three types of stratospheric clouds. They are :

1. Nacreous clouds extend from 10 to 100km in length and several kilometers in thickness. They are also called 'mother-of-pearl' clouds due to their glow with a sea-shell like iridescence.
2. The second type of clouds contain nitric acid instead of pure water.
3. The third type of clouds have the same chemical composition as nacreous clouds, but form at a slower rate, which results in a larger cloud with no iridescence.

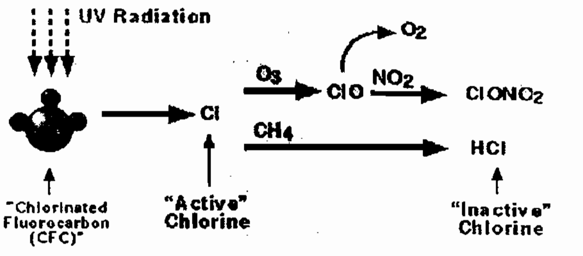
The chlorine released by the breakdown of CFCs exists initially as pure chlorine or as chlorine monoxide (active chlorine / instable) but these two forms react further to form compounds Chlorine nitrate and HCL that are stable (inactive chlorine).

Chlorine + methane → HCl + methyliumcation(CH3)

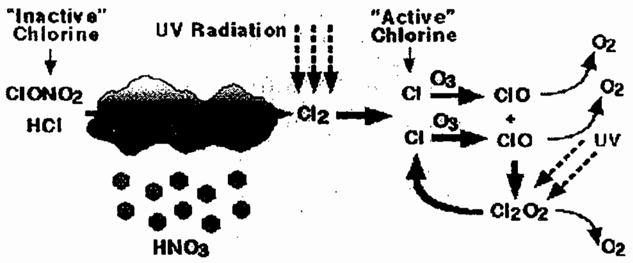
Chlorine monoxide + Nitrogen dioxide → Chlorine nitrate

The stable compounds HCL and $CLONO_2$ are reservoirs of chlorine, and therefore for chlorine to take part in reactions of any sort, it has to be freed.

Conversionof Chlorine from "Active" to "Inactive" States



Effect of Polar Stratospheric Clouds



There is a correlation exist between the cycle of ozone depletion and the presence of polar stratospheric clouds (PSCs) i.e. the ice particles of the cloud provided substrates for chemical reactions which freed chlorine from its reservoirs. Usually the reaction between HCl and $ClONO_2$ is very slow, but this reaction occurs at a faster rate in the presence of a suitable substrate which is provided by the stratospheric clouds at the poles.

HCl + Chlorine nitrate → molecular chlorine

It results in the formation of molecular chlorine and nitric acid. The molecular chlorine formed in the above reaction can be broken down to atomic chlorine and the ozone depletion reaction would continue. The PSCs not only activate chlorine, but they also absorb reactive nitrogen. If nitrogen oxides were present they would combine with chlorine monoxide to form a reservoir of chlorine nitrate ($ClONO_2$).

Dimer of chlorine monoxide : Stratospheric chlorine monoxide reacts with itself forming a dimer Cl2O2. This dimer is easily dissociated by sunlight, giving rise to free chlorine atoms which can further react to destroy ozone.

Every spring, a hole as big as the USA develops in the ozone layer over Antarctica, in the South Pole. A smaller hole develops each year over the Arctic, at the North Pole. And there are signs that the ozone layer is getting thinner all over the planet.

16.1.6. Why is the ozone hole predominant at the Antarctic?

- The Antarctic stratosphere is much colder. The low temperature enables the formation of Polar stratospheric Clouds (PSCs), below 20 km.
- Ozone absorbs sunlight, causing the characteristic increase in temperature with increase in altitude in the stratosphere. If ozone is being depleted, the air becomes cooler, further adding to the favourable conditions for the formation of PSCs and stabilization of the vortex. The vortex is a ring of rapidly circulating air that confines the ozone depletion in the Antarctic region.
- The longetivity of the Antarctic vortex is another factor, enhancing favourable conditions for the depletion of ozone. The vortex remains, in fact, throughout the polar winter, well into midspring whereas the vortex in the Arctic disintegrates by the time the polar spring (March-April) arrives.
- Typical happenings in the winter months leading to the ozone hole over the Antarctic.
- In June Antarctic winter begins, the vortex develops and the temperature falls enough for the clouds to form.
- During July and August PSCs denitrify and dehydrate the stratosphere through precipitation, hydrochloric acid and chlorine nitrate react on cloud surfaces to free chlorine and winter temperatures drops to their lowest point.
- In September sunlight returns to the centre of the vortex as the austral spring begins and PSCs disappear because of increasing temperature. ClO-ClO and ClO-BrO catalystic cycles destroy ozone.
- During October lowest levels of ozone are reached.
- In November, Polar vortex breaks down, ozone-rich are from the mid-latitudes replenishes the Antarctic stratosphere and ozone-poor air spreads over the southern hemisphere.

16.1.7. Arctic Ozone Hole

- The ozone hole has been increasingly evident over the Arctic as well.
- The Arctic ozone hole which swept across Britain in March 96 was the greatest depletion of ozone ever seen in the northern hemisphere.
- Scientists claim that it had been caused, in past, by a dramatic cooling of the upper atmosphere in the northern latitudes over.
- The ozone depletion over the northern hemisphere has been increasing steadily since the winter of 1992.
- Apart from the build-up of ozone depleting chemicals, the main cause is the increasing cold temperature in the arctic stratosphere which encourages the formulation of PSCs.

How ozone is measured?

- The ozone measurement instruments and techniques are varied. Some of them are the Dobson spectrophotometer and the filter ozonometer called M83, and total ozone mapping spectrometer (TOMS) in the Nimbus-7 satellite.

The Umheher technique

- The most common measure of total ozone abundance is the Dobson unit (named after the pioneering atmospheric physical Gordon Dobson) which is the thickness of the ozone column (compressed at Standard Temperature and Pressure (STP)) in milli-centimeters. At STP one Dobson unit is equal to 2.69x1020 molecules per square meter.

16.1.8. Environmental Effects Of Ozone Depletion

Decrease in the quantity of total-column ozone; tend to cause increased penetration of solar UV-B radiation (290-315nm) to the earth's surface. UV-B radiation is the most energetic component of sunlight reaching the earth's surface. It has profound effects on human health, animals, plants, micro-organisms, materials and on air quality.

Effects of human and animal health

- Potential risks include an increase in the incidence of and morbidity from eye diseases, skin cancer and infectious diseases.
- UV radiation has been shown in experimental systems to damage the cornea and lens of the eye. Experiments in animals show that UV exposure decreases the immune response to skin cancers, infectious agents and other antigens and can lead to unresponsiveness upon repeated challenges.
- In susceptible (light-skin coloured) populations, UV-B radiations is the key risk factor for development of non-melanoma skin cancer (NMSC).

Do you know?

All the chameleons have the ability to change color whenever they are subject to changes in stimuli, like a change in light, temperature or emotion. For example, when angered, they are likely to become darker in color.

Effects on terrestrial plants

- Psychological and developmental processes of plants are affected by UV-B radiation.
- Response to UV-B also varies considerably among species and also cultivars of the same species. In agriculture, this will necessitate using more UV-B tolerant cultivars and breeding new ones.
- In forests and grasslands, this is likely to result in changes in the composition of species; therefore there are implications for the biodiversity in different eco-systems.
- Indirect changes caused by UV-B such as changes in plant form, biomass allocation to parts of the plant, timing of developmental phases and second metabolism may be equally or sometimes more important that the damaging effects of UV-B.

Effects on aquatic ecosystems

- Exposure to solar UV-B radiation has been shown to affect both orientation mechanisms and motility in phytoplankton, resulting in reduced survival rates for these organisms.
- Solar UV-B radiation has been found to cause damage in the early developmental stages of fish, shrimp, crab, amphibians and other animals. The most severe effects are decreased reproductive capacity and impaired larval development.

Effects on bio-geochemical cycles

- Increases in solar UV radiation could affect terrestrial and aquatic bio-geochemical cycles, thus, altering both sources and sinks of greenhouse and chemically important trace gases.
- These potential changes would contribute to bio-sphere atmosphere feedbacks that reinforce the atmospheric build-up of these gases.

Effects on air quality

- Reduction in stratospheric ozone and the concomitant increase in UV-B radiation penetrating to the lower atmosphere result in higher photo dissociation rates of key trace gases that control the chemical reactivity of the troposphere.
- This can increase both production and destruction of ozone (O_3) and related oxidants such as hydrogen peroxide (H_2O_2), which are known to have adverse effects on human health, terrestrial plants, and outdoor materials.
- Changes in the atmospheric concentrations of the hydroxyl radical (OH) may change the atmospheric lifetimes of climatically important gases such as methane (CH_4) and the CFC substitutes.)
- Increased tropospheric reactivity could also lead to increased production of particulates such as cloud condensation nuclei, from the oxidation and subsequent nucleation of sulphur, of both antropogenic and natural origin (e.g. carbonyl sulphide and dimethylsulphide.

Effects on materials

- Synthetic polymers, naturally occurring bio-polymers, as well as some other materials of commercial interest are adversely affected by solar UV radiation.
- The application of these materials, particularly, plastics, in situations which demand routine exposure to sunlight is only possible through the use of light-stabilizers and / or surface treatment to protect them from sunlight.
- Any increase in solar UV-B content due to partial ozone depletion will therefore accelerate the photogradation rates of these materials, limiting their life outdoors.

Do you know?

The gray slender loris (primate). It is found in India and Sri Lanka. Its natural habitats are subtropical or tropical dry forests and subtropical or tropical moist lowland forests. It is threatened by habitat loss

◆ ◆ ◆ ◆ ◆ ◆

CHAPTER - 17

IMPACT OF CLIMATE CHANGE

17.1. AGRICULTURE AND FOOD SECURITY

- Climate Change can affect crop yield as well as the types of crops that can be grown in certain areas, by impacting agricultural inputs such as water for irrigation, amounts of solar radiation that affect plant growth, as well as the prevalence of pests.
- Rise in temperatures caused by increasing green house gases is likely to affect crops differently from region to region. For example, moderate warming (increase of 1 to 3°C in mean temperature) is expected to benefit crop yields in temperate regions, while in lower latitudes especially seasonally dry tropics, even moderate temperature increases (1 to 2°C) are likely to have negative impacts for major cereal crops. Warming of more than 3oC is expected to have negative effect on production in all regions.
- The Third Assessment Report of the IPCC, 2001 concluded that climate change would hit the poorest countries severely in terms of reducing the agricultural products.
- The Report claimed that crop yield would be reduced in most tropical and sub-tropical regions due to decreased water availability, and new or changed insect/pest incidence.
- In South Asia losses of many regional staples, such as rice, millet and maize could top 10 per cent by 2030.
- As a result of thawing of snow, the amount of arable land in high-latitude region is likely to increase by reduction of the amount of frozen lands.
- At the same time arable land along the coast lines are bound to be reduced as a result of rising sea level.
- Erosion, submergence of shorelines, salinity of the water table due to the increased sea levels, could mainly affect agriculture through inundation of low lying lands.
- In a recent study, the International Commission for Snow and Ice (ICSE) reported that Himalayan glaciers – that are the principal dry-season water sources of Asia's biggest rivers - Ganges, Indus, Brahmaputra, Yangtze, Mekong, Salween and Yellow – are shrinking quicker than anywhere else and that if current trends continue they could disappear altogether by 2035.
- If agricultural production in the low-income developing countries of Asia and Africa is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity will be manifold.

Do you know?

A conifer usually has a conical appearance and has an excurrent stem; i.e., its main stem is thickest at the base and gradually tapers toward the apex, with lateral branches in an acropetal succession.

17.1.1. Impacts on Indian agriculture

- A large part of the arable land in India is rain-fed, the productivity of agriculture depends on the rainfall and its pattern.
- Agriculture will be adversely affected not only by an increase or decrease in the overall amounts of rainfall but also by shifts in the timing of the rainfall.
- Any change in rainfall patterns poses a serious threat to agriculture, and therefore to the economy and food security.
- Summer rainfall accounts for almost 70 per cent of the total annual rainfall over India and is crucial to Indian agriculture.
- However, studies predict decline in summer rainfall by the 2050s.

- Semi arid regions of western India are expected to receive higher than normal rainfall as temperatures soar, while central India will experience a decrease of between 10 and 20 per cent in winter rainfall by the 2050s.
- Relatively small climate changes can cause large water resources problems particularly in arid and semi arid regions such as northwest India.
- Productivity of most crops may decrease due to increase in temperature and decrease in water availability, especially in Indo-Gangetic plains.
- This apart, there would be a decline in the productivity of rabi as compared to kharif season crops.
- Rising temperature would increase fertilizer requirement for the same production targets and result in higher GHG emissions, ammonia volatilization and cost of crop production.
- Increased frequencies of droughts, floods, storms and cyclones are likely to increase agricultural production variability.

Do you know?

The sloth bear, also known as the labiated bear, is a nocturnal insectivorous species of bear found wild within the Indian subcontinent. They feed on termites, honeybee colonies and fruits

17.2. WATER STRESS AND WATER INSECURITY

- Lack of access to water is a perturbing issue, particularly in developing countries.
- Climate change is expected to exacerbate current stresses on water resources.
- By 2020, between 75 and 250 million people are projected to be exposed to increased water stress due to climate change.
- Spreading water scarcity is contributing to food insecurity and heightened competitions for water both within and between countries.
- As the world population expands and the consumption of water spirals upwards, water problems are bound to intensify.
- Increase in temperature due to climate change has been widespread over the globe.
- Warming has resulted in decline in mountain glaciers and snow cover in both hemispheres and this is projected to accelerate throughout the 21st century.
- This will in turn lead to reducing water availability, hydropower potential, and would change the seasonal flow of rivers in regions supplied by melt water from major mountain ranges (e.g. Hindu-Kush, Himalaya, Andes).
- By 2050s freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease.
- A warmer climate will accelerate the hydrologic cycle, altering rainfall, magnitude and timing of run-off.
- Available research suggests a significant future increase in heavy rainfall events in many regions, while in some regions the mean rainfall is projected to decrease.
- The frequency of severe floods in large river basins has increased during the 20th century.
- Increasing floods poses challenges to society, physical infrastructure and water quality.
- Rising temperatures will further affect the physical, chemical and biological properties of fresh water lakes and rivers, with predominantly adverse impacts on many individual fresh water species, community composition and water quality.
- In coastal areas, sea level rise will exacerbate water resource constraints due to increased salinisation of groundwater supplies.

17.2.1. Impacts on water situation in India

- Water resources will come under increasing pressure in the Indian subcontinent due to the changing climate.
- The Himalayan glaciers are a source of fresh water for perennial rivers, in particular the Indus, Ganga, and Brahmaputra river systems.
- In recent decades, the Himalayan region seems to have undergone substantial changes as a result of extensive land use (e.g. deforestation, agricultural practices and urbanization), leading to frequent hydrological disasters, enhanced sedimentation and pollution of lakes.
- There is evidence that some Himalayan glaciers have retreated significantly since the 19th century.
- Available records suggest that the Gangotri glacier is retreating about 28 m per year.
- Glacial melt is expected to increase under changed climate conditions, which would lead to increased summer flows in some river systems

for a few decades, followed by a reduction in flow as the glaciers disappear.

- As a result of increase in temperature significant changes in rainfall pattern have been observed during the 20th century in India.
- A serious environmental problem has also been witnessed in the Indo-Gangetic Plain Region (IGPR) in the past whereby different rivers (including Kosi, Ganga, Ghaghara, Son, Indus and its tributaries and Yamuna) changed their course a number of times.
- The recent devastating floods in Nepal and Bihar due to change of course of River Kosi is a case in point.
- Available study suggests that food production has to be increased to the tune of 300 mt by 2020 in order to feed India's ever-growing population, which is likely to reach 1.30 billion by the year 2020.
- The total foodgrain production has to be increased by 50 per cent by 2020 to meet the requirement.
- It is feared that the fast increasing demand for food in the next two or three decades could be quite grim particularly in view of the serious problem of soil degradation and climate change.
- The rise in population will increase the demand for water leading to faster withdrawal of water and this in turn would reduce the recharging time of the water tables.
- As a result, availability of water is bound to reach critical levels sooner or later. During the past four decades, there has been a phenomenal increase in the growth of groundwater abstraction structures.
- Growing demand of water in agriculture, industrial and domestic sectors, has brought problems of overexploitation of the groundwater resource to the fore.
- The falling groundwater levels in various parts of the country have threatened the sustainability of the groundwater resources.
- At present, available statistics on water demand shows that the agriculture sector is the largest consumer of water in India.
- About 83% of the available water is used for agriculture alone. If used judiciously, the demand may come down to about 68% by the year 2050, though agriculture will still remain the largest consumer.
- In order to meet this demand, augmentation of the existing water resources by development of additional sources of water or conservation of the existing resources and their efficient use will be needed.
- It is evident that the impact of global warming threats are many and alarming.
- Water security in terms of quantity and quality pose problems for both developed and developing countries.
- However, the consequences of future climatic change may be felt more severely in developing countries such as India, whose economy is largely dependent on agriculture and is already under stress due to current population increase and associated demands for energy, freshwater and food.

Do you know?

Indian Flying Fox are the fruit eating bats. This species is found in roosts in large colonies of hundreds to thousands of individuals on large trees in rural and urban areas, close to agricultural fields, ponds and by the side of roads.

17.3. RISE IN SEA LEVELS

- Sea level rise is both due to thermal expansion as well as melting of ice sheets.
- Satellite observations available since the early 1990s show that since 1993, sea level has been rising at a rate per year, significantly higher than the average during the previous half-century.
- IPCC predicts that sea levels could rise rapidly with accelerated ice sheet disintegration.
- Global temperature increases of 3–4°C could result in 330 million people being permanently or temporarily displaced through flooding.
- Warming seas will also fuel more intense tropical storms.

17.3.1. Impacts on Coastal States in India

- The coastal states of Maharashtra, Goa and Gujarat face a grave risk from the sea level rise, which could flood land (including agricultural land) and cause damage to coastal infrastructure and other property.
- Goa will be the worst hit, losing a large percentage of its total land area, including many of its famous beaches and tourist infrastructure.

- Mumbai's northern suburbs like Versova beach and other populated areas along tidal mud flats and creeks are also vulnerable to land loss and increased flooding due to sea level rise.
- Flooding will displace a large number of people from the coasts putting a greater pressure on the civic amenities and rapid urbanisation.
- Sea water percolation due to inundations can diminish freshwater supplies making water scarcer.
- The states along the coasts like Orissa will experience worse cyclones. Many species living along the coastline are also threatened.
- The coral reefs that India has in its biosphere reserves are also saline sensitive and thus the rising sea level threatens their existence too, not only the coral reefs but the phytoplankton, the fish stocks and the human lives that are dependent on it are also in grave danger.
- People living in the Ganges Delta share the flood risks associated with rising sea levels.

17.4. ECOSYSTEMS AND BIO-DIVERSITY

- Climate Change has the potential to cause immense biodiversity loss, affecting both individual species and their ecosystems that support economic growth and human well being.
- The projected extinctions of flora and fauna in the future will be human driven i.e. due to adverse impact of human activities.
- According to International World Wildlife Fund (WWF) species from the tropics to the poles are at risk.
- Many species may be unable to move to new areas quickly enough to survive changes that rising temperatures will bring to their historic habitats.
- WWF asserted that one-fifth of the world's most vulnerable natural areas may be facing a "catastrophic" loss of species.
- It have catastrophic impact on the marine ecosystems. They will be affected not only by an increase in sea temperature and changes in ocean circulation, but also by ocean acidification, as the concentration of dissolved carbon dioxide (carbonic acid) rises.
- This is expected to negatively affect shell forming organisms, corals and their dependent ecosystems.

Do you know?

Grizzled giant squirrel is distributed in the patches of riparian forest along the Kaveri River and in the hill forests in the Tamil Nadu and Kerala states of southern India. IUCN Status - near threatened

17.4. IMPACTS ON INDIA'S BIODIVERSITY

- India is a land of mega-biodiversity, encompassing features from glaciers to deserts. However, climate change is posing grave threat to its ecosystems.
- Mountain ecosystems are hot spots of biodiversity. However, temperature increases and human activities are causing fragmentation and degradation of mountain biodiversity.
- The Himalayan Ecosystem is considered as the lifeline not only to India but also to our neighbouring countries such as China, Pakistan, Nepal, owing to the perennial rivers that arise out of the melting glaciers.
- It is home to the largest amount of glaciers after the North and the South Poles. However, climate change is threatening this life giver drastically.
- It is also predicted that there will be an increase in the phenomenon of Glacial Lake Outburst Floods (GLOFs) in the eastern and the central Himalayas, causing catastrophic flooding downstream, with serious damage to 'life, property, forests, farms, and infrastructure'.
- The melting glaciers of the Himalayas have a serious impact given the fact that they give rise to the perennial rivers that further flourishes the agriculture.
- The Himalayan rivers are closely interlinked with the Indo-Gangetic Ecosystem, which is primarily an agricultural ecosystem, nearly 65-70% of Indians having agriculture as their primary occupation.
- The National Environment Policy, 2006 states that the Indian Desert Ecosystems (arid and semi-arid region) occupies 127.3 mha (38.8%) of the country's geographical area and spreads over 10 states.
- The Indian desert fauna is extremely rich in species diversity of mammals and winter migratory birds.

- Recent studies have shown that deserts have shown signs of expansion, thus leading to a process called desertification.
- The climate patterns have altered the natural attributes of a desert region; for example the floods in the desert district of Barmer in Rajasthan in 2006.
- Coastal and Marine Ecosystem is one of the assets of India.
- The mangrove forests (wetlands) of the rivers and the coasts acts as carbon sink as well as a habitat for a unique and diverse species of plants and animals.
- The wetlands act as a natural barrier to flooding (that may be caused by the rising sea levels) and cyclones.
- The most explicit event in the perspective of climate change affecting the marine ecosystem is the example of coral bleaching.
- In the Peninsular India, even the rivers of the Peninsula are dependent on the monsoons, thus the Peninsular Ecosystem is basically a monsoon dependent ecosystem.
- India is heavily dependent on the monsoon to meet its agricultural and water needs, and also for protecting and propagating its rich biodiversity. Climate change is linked with the changing patterns observed in the monsoons of India.

Do you know?

Narcotic substances that are used for smoking purposes are called "fumitories," and those that are used for chewing purposes are called "masticatories."

17.5. CLIMATE CHANGE AND HEALTH

- Climate change poses a host of threats to the survival of mankind.
- Each year, about 800,000 people die from causes attributable to air pollution, 1.8 million from diarrhoea resulting from lack of access to clean water supply, sanitation, and poor hygiene, 3.5 million from malnutrition and approximately 60,000 in natural disasters.
- A warmer and more variable climate would result in higher levels of some air pollutants, increased transmission of diseases through unclean water and through contaminated food.
- Climate change has a direct impact on human health.
- For example, the warmer the climate the likelihood of its impact on human health becomes worse.
- It is anticipated that there will be an increase in the number of deaths due to greater frequency and severity of heat waves and other extreme weather events.
- Climate change and the resulting higher global temperatures are causing increasing frequency of floods and droughts leading to the risk of disease infections.
- Lack of freshwater during droughts and contamination of freshwater supplies during floods compromise hygiene, thus increasing rates of diarrhoeal disease.
- Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in hydrological cycle.
- Flooding also creates opportunities for breeding of disease carrying insects such as mosquitoes.
- Areas affected by frequent floods and drought conditions also witness large scale migration of populations to relatively stable regions leading to overcrowding and unhygienic conditions resulting in transmission of diseases like Japanese encephalitis and malaria.
- Climate change is a major factor in the spread of infectious diseases. Diseases, confined to one specific geographic region spread to other areas.
- The World Health Organization (WHO) in their studies have indicated that due to rising temperatures, malaria cases are now being reported for the first time from countries like Nepal and Bhutan.
- It has also been predicted that an additional 220-400 million people could be exposed to malaria- a disease that claims around 1 million lives annually.
- Dengue fever is already in evidence at higher levels of elevation in Latin America and parts of East Asia.
- Studies suggest that climate change may swell the population at risk of malaria in Africa by 90 million by 2030, and the global population at risk of dengue by 2 billion by 2080s.

- Rising temperatures and changing patterns of rainfall are projected to decrease crop yields in many developing countries, stressing food supplies. This will ultimately translate into wider prevalence of malnutrition/ undernutrition. In some African countries, yields from rain-fed agriculture could be reduced by up to 50 per cent by 2020.
- Emission of the Green House Gases have been responsible for the depletion of ozone layer, which protects the Earth from the harmful direct rays of the sun. Depletion of stratospheric ozone results in higher exposure to the ultra violet rays of the sun, leading to an increase in the incidents of skin cancer. It could also lead to an increase in the number of people suffering from eye diseases such as cataract. It is also thought to cause suppression of the immune system.
- The projections by WHO and IPCC suggest that the negative effects of climate change on health are greater.
- In addition, the negative effects are concentrated on poor populations that already have compromised health prospects, thus widening the inequality gap between the most and the least privileged.
- The balance of positive and negative health impacts will vary from one location to another, and will alter over time as temperatures continue to rise.

Do you know?

Saponins are a group of water-soluble glucosides that yield soap froth in water, form emulsions with oils and fats, and are capable of absorbing large amounts of gases such as carbon dioxide. Soap nut tree yields saponins.

◆

CHAPTER - 18

MITIGATION STRATEGIES

18.1. CARBON SEQUESTRATION:

- Carbon capture and storage, also known as CCS or carbon sequestration, describes the technologies designed to tackle global warming by capturing CO2 at power stations, industrial sites or even directly from the air and permanently storing it underground.
- Carbon sequestration describes long-term storage of carbon dioxide or other forms of carbon to either mitigate or defer global warming.
- It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases, which are released by burning fossil fuels.

Sinks

- Carbon sequestration may be carried out by pumping carbon into 'carbon sinks'— an area that absorbs carbon.
    - Natural sinks - Oceans, forests, soil etc.
    - Artificial sinks - Depleted oil reserves, unmineable mines, etc.
- Carbon capture has actually been in use for years. The oil and gas industries have used carbon capture for decades as a way to enhance oil and gas recovery. Only recently have we started thinking about capturing carbon for environmental reasons.

There are three main steps to carbon capture and storage (CCS) –

- trapping and separating the CO2 from other gases,
- transporting this captured CO2 to a storage location, and
- storing that CO2 far away from the atmosphere (underground or deep in the ocean).

Types of Sequestration:

- There are number of technologies under investigation for sequestering carbon from the atmosphere. These can be discussed under three main categories:
- Ocean Sequestration: Carbon stored in oceans through direct injection or fertilization.
- Geologic Sequestration: Natural pore spaces in geologic formations serve as reservoirs for long-term carbon dioxide storage.
- Terrestrial Sequestration: A large amount of carbon is stored in soils and vegetation, which are our natural carbon sinks. Increasing carbon fixation through photosynthesis, slowing down or reducing decomposition of organic matter, and changing land use practices can enhance carbon uptake in these natural sinks.
- Geologic Sequestration is thought to have the largest potential for near-term application.

Geologic Sequestration Trapping Mechanisms

- Hydrodynamic Trapping: Carbon dioxide can be trapped as a gas under low-permeability cap rock (much like natural gas is stored in gas reservoirs).
- Solubility Trapping: Carbon dioxide can be dissolved into a liquid, such as water or oil.
- Mineral Carbonation: Carbon dioxide can react with the minerals, fluids, and organic matter in a geologic formation to form stable compounds/minerals; largely calcium, iron, and magnesium carbonates.
- Carbon dioxide can be effectively stored in the earth's subsurface by hydrodynamic trapping and solubility trapping - usually a combination of the two is most effective.

Do you know?

Asian golden cat prefer forest habitats interspersed with rocky areas, and are found in dry deciduous, subtropical evergreen and tropical rainforests. In India it is distribution in assam& arunachal Pradesh. IUCN Status – near threatened.

18.2. CARBON SINK

- Unlike black and brown carbon that contribute to atmospheric green house gases, green and blue carbon sequestrate the atmosphere green house gases

Green Carbon

- Green carbon is carbon removed by photosynthesis and stored in the plants and soil of natural ecosystems and is a vital part of the global carbon cycle.
- Many plants and most crops, have short lives and release much of their carbon at the end of each season, but forest biomass accumulates carbon over decades and centuries.
- Furthermore, forests can accumulate large amounts of CO2 in relatively short periods, typically several decades.
- Afforestation and reforestation are measures that can be taken to enhance biological carbon sequestration.

Blue Carbon

- Blue Carbon refers to coastal, aquatic and marine carbon sinks held by the indicative vegetation, marine organism and sediments.
- In particular, coastal ecosystems such as tidal marshes, mangroves, and seagrasses remove carbon from the atmosphere and ocean, storing it in plants and depositing it in the sediment below them by natural processes.
- These coastal ecosystems are very efficient at sequestering and storing carbon - each square mile of these systems can remove carbon from the atmosphere and oceans at rates higher than each square mile of mature tropical forests..
- Furthermore, coastal ecosystems have been found to store huge quantities of carbon in organic rich sediments - up to 5 times more carbon than many temperate and tropical forests.
- These ecosystems are found in all continents, except Antarctica.

Why is Blue Carbon Ecosystem Important?

- Preventing degradation and destruction and promoting restoration of coastal ecosystems is a significant tool to mitigate climate change.
- The coastal ecosystems of mangroves, tidal marshes, and seagrasses are some of the most rapidly disappearing natural systems on Earth.
- When lost they not only stop sequestering carbon but also release their stores of carbon and become new sources of climate change causing carbon emissions which can last for centuries.

The Blue Carbon Initiative

- The Blue Carbon Initiative is the first integrated program with a comprehensive and coordinated global agenda focused on mitigating climate change through the conservation and restoration of coastal marine ecosystems.

International Cooperation

- Conservation International (CI), the International Union for Conservation of Nature (IUCN), and the Intergovernmental Oceanic Commission (IOC) of UNESCO is collaborating with governments, research institutions, non-governmental and international organizations, and communities around the world to
- Develop management approaches, financial incentives and policy mechanisms for ensuring conservation and restoration of coastal Blue Carbon ecosystems;
- Engage local, national, and international governments to ensure policies and regulations support coastal Blue Carbon conservation, management and financing;
- Develop comprehensive methods for coastal carbon accounting;
- Develop incentive mechanisms such as carbon payment schemes for Blue Carbon projects; and
- Implement projects around the world that demonstrate the feasibility of coastal Blue Carbon accounting, management, and incentive agreements;
- Support scientific research into the role and importance of coastal Blue Carbon ecosystems for climate change mitigation.

Do you know?

The seeds of Phytelephas macrocarpa, in the family Arecaceae, commonly called "ivory nut" or "tagua palm tree," is the chief source of vegetable ivory. It is extensively used as a substitute for true ivory. It can be carved and used in the manufacture of buttons, chess pieces, poker chips, dice, knobs, inlays, billiard balls, toys, etc. Metroxylon amicarum, in the Arecaceae family, can likewise be used for these purposes

All Rights Reserved. No part of this material may be reproduced in any form or by any means, without permission in writing.

18.3. CARBON CREDIT :

- A carbon credit is a tradeable certificate or permit representing the right to emit one tonne of carbon or carbon dioxide equivalent (tCO2e).
- One carbon credit is equal to one ton of carbon dioxide, or in some markets, carbon dioxide equivalent gases.

How does one earn a carbon credit?

- An organisation which produces one tonne less of carbon or carbon dioxide equivalent than the standard level of carbon emission allowed for its outfit or activity, earns a carbon credit.

How does I t help?

- Countries which are signatories to the Kyoto Protocol under the UNFCCC have laid down gas emission norms for their companies to be met by 2012. In such cases, a company has two ways to reduce emissions.
  - (i) It can reduce the GHG (greenhouse gases) by adopting new technology or improving upon the existing technology to attain the new norms for emission of gases.
  - (ii) It can tie up with developing nations and help them set up new technology that is eco-friendly, thereby helping developing country or its companies 'earn' credits. This credit becomes a permit for the company to emit GHGs in its own country. However, only a portion of carbon credits of the company in developing country can be transferred to the company in developed country.

Developing countries

- Developing countries like India and China are likely to emerge as the biggest sellers and Europe is going to be the biggest buyers of carbon credits.
- Last year global carbon credit trading was estimated at $5 billion, with India's contribution at around $1 billion.
- China is currently the largest seller of carbon credits controlling about 70% of the market share.
- Carbon, like any other commodity, has begun to be traded on India's Multi Commodity Exchange.
- MCX has become first exchange in Asia to trade carbon credits.

Do you know?

Several species of nitrogen-fixing bacteria of Rhizobium, live inside the root nodules of leguminous trees. Similarly, Frankia, a nitrogen-fixing mycelial bacterium, is associated symbiotically with the root nodules of several non-legume plants, including Alnus, Casuarina, Coriaria, Myrica and Rubus. Both Rhizobium and Frankia are capable of fixing atmospheric nitrogen.

18.4. CARBON OFFSETTING:

- Carbon offsets are credits for reductions in greenhouse gas emissions made at another location, such as wind farms which create renewable energy and reduce the need for fossil-fuel powered energy.
- Carbon offsets are quantified and sold in metric tonnes of carbon dioxide equivalent (CO2e).
- Buying one tonne of carbon offsets means there will be one less tonne of carbon dioxide in the atmosphere than there would otherwise have been.
- Carbon offsetting is often the fastest way to achieve the deepest reductions within businesses and it also often delivers added benefits at the project site, such as employment opportunities, community development programmes and training and education.
- For a carbon offset to be credible it must meet essential quality criteria, including proof that it is additional (the reduction in emissions would not have occurred without the carbon finance), that it will be retired from the carbon market so it cannot be double counted, and that it addresses issues such as permanence (it delivers the reductions it stated) and leakage (the emission reduction in one area doesn't cause an increase in emissions somewhere else)

Example:

- Business A1 is unable to reduce 100 tonnes of its CO2 emissions in the short term.
- There is a project somewhere else in the world which could save 100 tonnes easily, but they need a cash injection.
- For example, a community in India could swap from carbon intensive kerosene as an energy source to solar panels – but they can't afford the solar panels.

- Through the purchase of carbon offsets, you provide the financial assistance to subsidise the cost of getting solar panels onto housing, and through that means you have enabled a saving of 100 tonnes of CO2.
- Business A1 has therefore reduced global net CO2 emissions by 100 tonnes.
- The added benefit is that Business A1 has helped facilitate a step change in local technology in a developing market.

18.5. CARBON TAX :

- Carbon tax is the potential alternative to the 'cap and trade' method currently used by the protocol.
- This tax is based on the amount of carbon contained in a fuel such as coal, etc.
- The aim of this tax is to cause less fossil fuel use and hopefully cause an incentive to use other sources of energy.
- If the carbon tax was implemented it would be gradual and start at a low amount and increase over time to allow better industry and technology to be developed.
- Five primary reasons why a carbon tax could prove more beneficial than the 'cap and trade' system.

1. Predictability – the tax could help predict energy prices which might also help investments in energy efficiency and alternate fuels.
2. Implementation - a carbon tax could be put into use much quicker compared to the legalities that go along with the 'cap and trade' method.
3. Understandable – the carbon tax is simpler to understand and may therefore be embraced more by everyday people
4. Lack of Manipulation – special interest groups have less of a chance to manipulate a carbon tax because of its simplicity.
5. Rebates – like other forms of taxes, the carbon tax could be open for rebates to the public

India's Position on carbon tax:

- India will bring a WTO challenge against any "carbon taxes" that rich countries impose on Indian imports.
- "If they impose such a tax, we will take them to the WTO dispute settlement forum," "We will deal [with this] through hard negotiations. Such barriers are not going to be WTO-compatible and we will fight it." - the minister, MoEF
- Both United States and European Union have discussed the possibility of imposing tariffs or other forms of "border carbon adjustment" on goods imported from countries with tax regulations on greenhouse gas emissions.

Do you know?

Generally, softwood tracheids are preferred over hardwood fibers for papermaking because the tracheids of conifers are longer (about 2–4 mm) than are hardwood fibers (0.5–1.5 mm).

18.6. GEO-ENGINEERING:

- Geo-engineering primarily aims at modifying and cooling Earth's environment, defeating the environmental damage and ensuing climate changes to make the planet more inhabitable. Geoengineering, at this point, is still only a theoretical Concept
- Hoisting parasols, placing mirrors in space, whitening the stratosphere with sulfate aerosols, whitewashing building roofs to reflect sunlight or flinging iron filings into the ocean to promote carbon-gulping algae are some of the modes.

How Geoengineering Works: 5 Big Plans to Stop Global Warming

1. **Copy a Volcano**

- A volcanic eruption can bellow many million tons of sulfur-dioxide gas into the atmosphere, creating a cloud that blocks some of the sun's radiation. By injecting the atmosphere with sulfur, some scientists believe they could likewise block solar radiation and potentially cool the planet.
- Those droplets are particularly good at scattering the sun's light back out into space. And because sulfur doesn't heat the stratosphere as much as other aerosols, it wouldn't work against the cooling effect. Hydrogen sulfide is an even better candidate for atmospheric seeding than sulfur dioxide.

2. **Shoot Mirrors Into Space**

- In order to deflect enough sunlight to bring the Earth's climate back to its pre-industrial level, geoengineers plan to launch a mirror, the size of

All Rights Reserved. No part of this material may be reproduced in any form or by any means, without permission in writing.

Greenland and strategically position it between the planet and the sun.

3. **Seed the Sea with Iron**

- Scientist suggests iron will be the key to turn things around. Phytoplankton, which dwell near the surface, prefer iron.
- They are also adapt at pulling carbon out of the atmosphere during photosynthesis.
- When they die after about 60 days, the carbon the organisms have consumed falls to the bottom of the ocean.
- By pumping iron into the sea and stimulating phytoplankton to grow like crazy, scientist believe, global warming could be reversed.

4. **Whiten the Clouds with Wind-Powered Ships**

- Scientist hopes, like the volcanic eruption, the tops of clouds also reflect solar radiation. Spraying a lot of seawater into the sky by wind powered remotely activated ships to whiten the clouds and thus it will reflect solar radiation.

5. **Build Fake Trees**

- "artificial tree," a scaled-down version of an earlier prototype capable of capturing a ton of carbon in the atmosphere per day.
- Panels covering the surface of the tree--which would need to be about 50 square meters--will be made of an absorbent resin that reacts with carbon dioxide in the air to form a solid.
- It can be compared to a furnace filter, capable of pulling particles out of the air.
- The panels, or "boxes," can be removed and exposed to 113 F steam, which effectively cleans the filter.
- The chemical reaction with the steam causes the solid to release the carbon it has captured, which can then seize as liquid CO_2.
- But pulling carbon dioxide from the atmosphere is only half the battle--afterwards it must be sequestered, or permanently trapped.

Do you know?

Mugger crocodile is a freshwater species, which primarily occupies Indian lakes, rivers and marshes. It prefers slow-moving, shallower bodies of water and may be found in man-made reservoirs and irrigation canals.

How sequestrated CO_2 can be commercials used?

- Horticulturists need CO_2 in greenhouses for plants to use during photosynthesis,
- For dry ice production, and
- For developing new kinds of plastic and concrete that can be made with CO_2.

Drawbacks

- Scientists have no idea whether they could shut-down some of these geoengineering projects once they start.
- Geoengineering treats the symptoms of global warming, and could very well undermine efforts to address the root cause.
- people may feel as though they don't need to reduce their personal carbon emissions and companies may continue to conduct business as usual, expecting researchers to clean up the mess.
- The cost, maintenance for geoengineering projects are too high.

◆◆◆◆◆◆

CHAPTER - 19

INDIA AND CLIMATE CHANGE

19.1. INDIA'S POSITION ON CLIMATE CHANGE

- Prime Minister has stated that India's per capita emission levels will never exceed that of the per capita emission levels of developed countries.
- India cannot and will not take on emission reduction targets because:
  - Poverty eradication and social and economic development are the first and over-riding priorities.
  - Each human being has equal right to global atmospheric resources (i.e., Principle of Equity).
  - "Common but differentiated responsibility" is the basis for all climate change actions.
- India will continue to be a low-carbon economy (World Bank study).
- India's primary focus is on "adaptation", with specific focus for "mitigation".
- India has already unveiled a comprehensive National Action Plan on Climate Change whose activities are in the public domain. Work on the Action Plan has been initiated.
- Only those Nationally Appropriate Mitigation Actions (NAMAs) can be subject to international monitoring, reporting and verification that are enabled and supported by international finance and technology transfer.
- India wants a comprehensive approach to Reducing Emissions from Deforestation & Forest Degradation (REDD) and advocates REDD+ that includes conservation, afforestation and sustainable management of forests.
- India advocates collaborative research in future low-carbon technology and access to intellectual property rights (IPRs) as global public goods.

19.2. INDIA'S PROACTIVE CONTRIBUTION TO CLIMATE CHANGE NEGOTIATIONS

- Actively involved with G77 & China to evolve common position on negotiations
- Made 9 submissions to UNFCCC on Finance, Technology, Forestry and other areas, e.g.,
  - Suggested a mechanism for technology transfer and development
  - Suggested a financial architecture for climate change
  - Presented a proposal for comprehensive approach to REDD+
- Worked with China, Brazil, South Africa and 33 other countries to present a joint proposal for emission reduction targets by Annex 1 countries in second commitment period

19.3. CURRENT CARBON DIOXIDE EMISSIONS IN INDIA

- India's CO2 emissions per capita are well below the world's average. Per capita carbon dioxide emissions of some regions in the world in 2004 are as follows:
- A comparison of India's per capita GHG emissions with some other countries

Country	Per-Capita Carbon-dioxide emissions (metric tons)
USA	20.01
EU	9.40
Japan	9.87
China	3.60
Russia	11.71
India	1.02
World Average	4.25

19.4. OBSERVED CLIMATE AND WEATHER CHANGES IN INDIA

- India's National Communication (NATCOM) to UNFCCC has consolidated some of the observed changes in climate parameters in India. No firm link between the documented changes described below and warming due to anthropogenic climate change has yet been established.

19.4.1. Surface Temperature

- At the national level, increase of — 0.4° C has been observed in surface air temperatures over the past century. A warming trend has been observed along the west coast, in central India, the interior peninsula, and north-eastern India. However, cooling trends have been observed in north-west India and parts of south India.

19.4.2. Rainfall

- While the observed monsoon rainfall at the all-India level does not show any significant trend, regional monsoon variations have been recorded.
- A trend of increasing monsoon seasonal rainfall has been found along the west coast, northern Andhra Pradesh, and north-western India (+10% to +12% of the normal over the last 100 years) while a trend of decreasing monsoon seasonal rainfall has been observed over eastern Madhya Pradesh, north-eastern India, and some parts of Gujarat and Kerala (-6% to –8% of the normal over the last 100 years).

19.4.3. Extreme Weather Events

- Instrument records over the past 130 years do not indicate any marked long-term trend in the frequencies of large-scale droughts and floods. Trends are however observed in multi-decadal periods of more frequent droughts, followed by less severe droughts.
- There has been an overall increasing trend in severe storm incidence along the coast at the rate of 0.011 events per year. While the states of West Bengal and Gujarat have reported increasing trends, a decline has been observed in Orissa.

19.4.4. Rise in Sea Level

- The records of coastal tide gauges in the north Indian Ocean for more than 40 years, reports that sea level rise was between 1.06-1.75 mm per year. These rates are consistent with 1-2 mm per year global sea level rise estimates of IPCC.

19.4.5. Impacts on Himalayan Glaciers

- The Himalayas possess one of the largest resources of snow and ice and its glaciers form a source of water for the perennial rivers such as the Indus, the Ganga, and the Brahmaputra.
- Glacial melt may impact their long-term lean-season flows, with adverse impacts on the economy in terms of water availability and hydropower generation.
- The available monitoring data on Himalayan glaciers indicates that while recession of some glaciers has occurred in some Himalayan regions in recent years, the trend is not consistent across the entire mountain chain. It is accordingly, too early to establish long-term trends, or their causation, in respect of which there are several hypotheses.

Do you know?

Tripura is one of the highest CVP (Climate, Vegetation, Precipitation) index zones (a measure of potential productivity) in the country.

19.5. CURRENT ACTIONS FOR ADAPTATION AND MITIGATION

- Adaptation, in the context of climate change, comprises the measures taken to minimize the adverse impacts of climate change, e.g. relocating the communities living close to the sea shore, for instance, to cope with the rising sea level or switching to crops that can withstand higher temperatures.
- Mitigation comprises measures to reduce the emissions of greenhouse gases that cause climate change in the first place, e.g. by switching to renewable sources of energy such as solar energy or wind energy, or nuclear energy instead of burning fossil fuel in thermal power stations.
- Current Indian government expenditure on adaptation to climate variability, exceeds 2.6% of the GDP, with agriculture, water resources, health and sanitation, forests, coastal-zone infrastructure and extreme weather events, being specific areas of concern.

19.5.1. AGRICULTURE

- Two risk-financing programmes support adaptation to climate impacts. The Crop Insurance Scheme sup-ports the insurance of farmers against climate risks, and the Credit Support Mechanism facilitates the extension of credit to farmers, especially for crop failure due to climate variability.

19.5.2. CROP IMPROVEMENT

- The present programmes address measures such as development of arid-land crops and pest management, as well as capacity building of extension workers and NGOs to support better vulnerability reducing practices.

19.5.3. DROUGHT PROOFING

- The current programmes seek to minimize the adverse effects of drought on production of crops and livestock, and on productivity of land, water and human resources, so as to ultimately lead to drought proofing of the affected areas.
- They also aim to promote overall economic development and improve the socio-economic conditions of the resource poor and disadvantaged sections inhabiting the programme areas.

19.5.4. FORESTRY

- India has a strong and rapidly growing afforestation programme. The afforestation process was accelerated by the enactment of the Forest Conservation Act of 1980, which aimed at stopping the clearing and degradation of forests through a strict, centralized control of the rights to use forest land and mandatory requirements of compensatory afforestation in case of any diversion of forest land for any non-forestry purpose.
- In addition an aggressive afforestation and sustainable forest management programme resulted in annual reforestation of 1.78 mha during 1985-1997, and is currently 1.1 mha annually. Due to this, the carbon stocks in Indian forests have increased over the last 20 years (during 1986 to 2005) to 9 -10 gigatons of carbon (GtC).

19.5.5. WATER

- The National Water Policy (2002) stresses that non-conventional methods for utilization of water, including inter-basin transfers, artificial recharge of groundwater, and desalination of brackish or sea water, as well as traditional water conservation practices like rainwater harvesting, including roof-top rainwater harvesting, should be practised to increase the utilizable water resources. Many states now have mandatory water harvesting programmes in several cities.

19.5.6. COASTAL REGIONS

- In coastal regions, restrictions have been imposed in the area between 200m and 500m of the HTL (high tide line) while special restrictions have been imposed in the area up to 200m to protect the sensitive coastal ecosystems and prevent their exploitation.
- This, simultaneously, addresses the concerns of the coastal population and their livelihood. Some specific measures taken in this regard include construction of coastal protection infrastructure and cyclone shelters, as well as plantation of coastal forests and mangroves.

19.5.7. HEALTH

- The prime objective present of health programmes is the surveillance and control of vector borne diseases such as Malaria, Kala-azar, Japanese Encephalitis, Filaria and Dengue. Programmes also provide for emergency medical relief in the case of natural calamities, and to train and develop human resources for these tasks.

19.5.8. DISASTER MANAGEMENT

- The National Disaster Management programme provides grants-in-aid to victims of weather related disasters, and manages disaster relief operations. It also supports proactive disaster prevention programmes, including dissemination of information and training of disaster-management staff.

Do you know?

A Chapter on Sustainable Development and Climate Change has been for the first time introduced in the annual Economic Survey. This new chapter reflects the growing challenges of sustainable development and climate change. Pressures on land, air, water, forests and loss of plant and animal habitant are growing.

19.6. INDIA'S NATIONAL ACTION PLAN ON CLIMATE CHANGE

In dealing with the challenge of climate change we must act on several fronts in a focused manner simultaneously. The National Action Plan hinges on the development and use of new technologies. The implementation of the Plan would be through appropriate institutional mechanisms suited for effective delivery of each individual Mission's objectives and include public private partnerships and civil society action. The focus will be on promoting understanding of climate change, adaptation and mitigation, energy efficiency and natural resource conservation.

There are Eight National Missions which form the core of the National Action Plan, representing multipronged, long-term and integrated strategies for achieving key goals in the context of climate change. While several of these programmes are already part of our current actions, they may need a change in direction, enhancement of scope and effectiveness and accelerated implementation of time-bound plans.

Do you know?

The Economic Survey 2011-12, suggests to make lower carbon sustainable growth a central element of our Twelfth Five Year Plan commencing in April 2012. The Survey points out that India's per capita CO_2 emissions are much lower (1.52 CO_2 tons) than those of the developed countries even if historical emissions are excluded.

19.6.1. NATIONAL SOLAR MISSION

- The National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge.

Objective

- To establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible.
- The Mission will adopt a 3-phase approach,
  - spanning the remaining period of the 11th Plan and first year of the 12th Plan (up to 2012-13) as Phase 1,
  - the remaining 4 years of the 12th Plan (2013-17) as Phase 2 and
  - the 13th Plan (2017-22) as Phase 3.
- At the end of each plan, and mid-term during the 12th and 13th Plans, there will be an evaluation of progress, review of capacity and targets for subsequent phases, based on emerging cost and technology trends, both domestic and global.
- The aim would be to protect Government from subsidy exposure in case expected cost reduction does not materialize or is more rapid than expected.
- The first phase (up to 2013) will focus on capturing of the low hanging options in solar thermal; on promoting off-grid systems to serve populations without access to commercial energy and modest capacity addition in grid-based systems.
- In the second phase, after taking into account the experience of the initial years, capacity will be aggressively ramped up to create conditions for up scaled and competitive solar energy penetration in the country.

Mission targets are:

1. To create an enabling policy framework for the deployment of 20,000 MW of solar power by 2022.
2. To ramp up capacity of grid-connected solar power generation to 1000 MW within three years – by 2013; an additional 3000 MW by 2017 through the mandatory use of the renewable purchase obligation by utilities backed with a preferential tariff. This capacity can be more than doubled – reaching 10,000MW installed power by 2017 or more, based on the enhanced and enabled international finance and technology transfer. The ambitious target for 2022 of 20,000 MW or more, will be dependent on the 'learning' of the first two phases, which if successful, could lead to conditions of grid-competitive solar power. The transition could be appropriately up scaled, based on availability of international finance and technology.
3. To create favourable conditions for solar manufacturing capability, particularly solar thermal for indigenous production and market leadership.
4. To promote programmes for off grid applications, reaching 1000 MW by 2017 and 2000 MW by 2022
5. To achieve 15 million sq. meters solar thermal collector area by 2017 and 20 million by 2022.
6. To deploy 20 million solar lighting systems for rural areas by 2022.

Do you know?

In Kaziranga, which has the highest concentration of the one-horned rhinoceros, the figure has gone up from 2,048 in 2009 to 2,990 now, despite the death of roughly 120 rhinos between 2009 and 2011. The rhino census, also registered 100 rhinos in Orang National Park and 93 in Pobitora wildlife sanctuary, besides 22 that have been translocated to Manas National Park over the past four years.

19.6.2. THE NATIONAL MISSION FOR ENHANCED ENERGY EFFICIENCY (NMEEE)

- The National Mission for Enhanced Energy Efficiency (NMEEE), which seeks to strengthen the market for energy efficiency by creating conducive regulatory and policy regime.
- NMEEE has been envisaged to foster innovative and sustainable business models to the energy efficiency sector.
- The NMEEE seeks to create and sustain markets for energy efficiency in the entire country which will benefit the country and the consumers".

Objective

- Promoting innovative policy and regulatory regimes, financing mechanisms, and business models which not only create, but also sustain markets for energy efficiency in a transparent manner with clear deliverables to be achieved in a time bound manner.

Mission Goals

- Market-based approaches to unlock energy efficiency opportunities, estimated to be about Rs. 74,000 Crores

  By 2014-15:

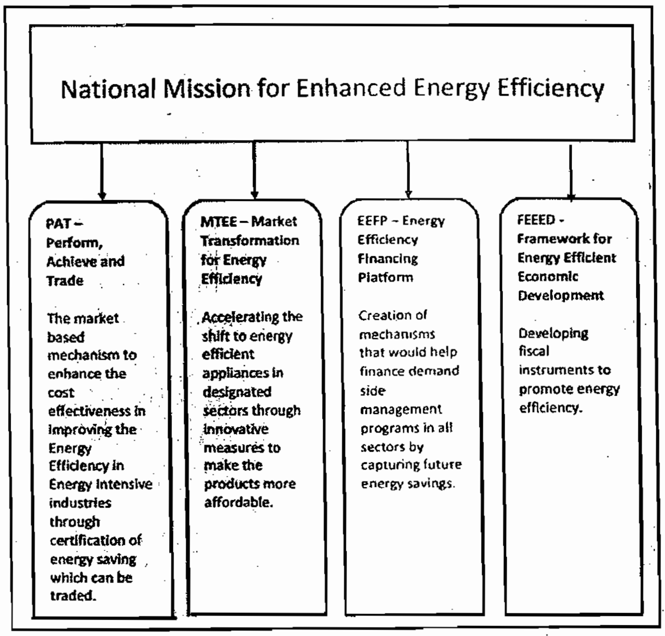
  - Annual fuel savings in excess of 23 million toe
  - Cumulative avoided electricity capacity addition of 19,000 MW
  - CO_2 emission mitigation of 98 million tons per year
- Four New Initiatives to Enhance Energy Efficiency:

a) Perform Achieve and Trade

b) Market Transformation for Energy Efficiency

c) Energy Efficiency Financing Platform (EEP)

d) Framework for Energy Efficient Economic Development (FEEED)


National Mission for Enhanced Energy Efficiency
PAT – Perform, Achieve and Trade
The market based mechanism to enhance the cost effectiveness in improving the Energy Efficiency in Energy Intensive industries through certification of energy saving which can be traded.
MTEE – Market Transformation for Energy Efficiency
Accelerating the shift to energy efficient appliances in designated sectors through innovative measures to make the products more affordable.
EEFP – Energy Efficiency Financing Platform
Creation of mechanisms that would help finance demand side management programs in all sectors by capturing future energy savings.
FEEED - Framework for Energy Efficient Economic Development
Developing fiscal instruments to promote energy efficiency.

19.6.3. NATIONAL MISSION ON SUSTAINABLE HABITAT

- "National Mission on Sustainable Habitat" seeks to promote sustainability of habitats through improvements in energy efficiency in buildings, urban planning, improved management of solid and liquid waste, modal shift towards public transport and conservation through appropriate changes in legal and regulatory framework.
- It also seeks to improve ability of habitats to adapt to climate change by improving resilience of infrastructure, community based disaster management and measures for improving advance warning systems for extreme weather events.
- It will broadly cover the following aspects:
  - Extension of the energy conservation building code - which addresses the design of new and large commercial buildings to optimize their energy demand;
  - Better urban planning and modal shift to public transport - make long term transport plans to facilitate the growth of medium and small cities in such a way that ensures efficient and convenient public transport;
  - Recycling of material and urban waste management - a special area of focus will be development of technology for producing power form waste.

- The National Mission will include a major R&D programme, focusing on bio-chemical conversion, waste water use, sewage utilization and recycling options.

Do you know?

A rainforest is a forested biome with high annual rainfall. Tropical rainforests arise due to the inter-tropical convergence zone. The largest tropical rainforests exist in the Amazon basin, Nicaragua, equatorial Africa, southeastern Asia from Myanmar to Indonesia, eastern Queensland and part of Australia.

The beneficial effects of rain forests are manifold. It is also called "lungs of the world" and act as major consumers of atmospheric carbon and play a large role in cooling air.

It is estimated that the rainforests were reduced by about 58,000 km^2 annually in the 1990s. Rainforests used to cover 14% of the Earth's surface. This percentage is now down to 6% and it is estimated by study that the remaining natural rainforests could disappear within 40 years.

19.6.4. NATIONAL WATER MISSION (NWM)

MISSION OBJECTIVES

- Ensuring integrated water resource management for conservation of water, minimization of wastage and equitable distribution both across and within states.
- Developing a framework for optimum water use through increase in water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing, taking the National Water Policy (NWP) into consideration.
- Ensuring that a considerable share of water needs of urban areas is met through recycling of waste water.
- Meeting water requirements of coastal cities (with inadequate alternative sources of water) through the adoption of new and appropriate technologies such as low-temperature desalination technologies allowing use of ocean water.
- Revisiting NWP to ensure basin-level management strategies to deal with variability in rainfall and river flows due to climate change, including enhancement of storage both above and below ground, implementation of rainwater harvesting and establishment of equitable and efficient management structures.
- Developing new regulatory structures to optimize efficiency of existing irrigation systems, to rehabilitate run-down systems and to expand irrigation to increase storage capacity.
- Promotion of water-neutral and water-positive technologies through the design of a proper incentive structure combined with recharging of underground water sources and adoption of large-scale irrigation programme based on efficient methods of irrigation.

Do you know?

1. The 2009 State of the Environment Report by the Ministry of Environment and Forests (MoEF) clubs the issues under five key main challenges faced by India, which are climate change, food, security, water security, energy security and managing urbanization.
2. Mercury in the environment can be reduced by using alternative products that don't contain mercury, cleaning up spills properly, recycling mercury-containing products and properly handling and disposing of mercury-containing equipment.

19.6.5. NATIONAL MISSION FOR SUSTAINING THE HIMALAYAN ECOSYSTEM (NMSHE)

- The most crucial and primary objective of the mission is to develop a sustainable National capacity to continuously assess the health status of the Himalayan Ecosystem and enable policy bodies in their policy-formulation functions and assist States in the Indian Himalayan Region with their implementation of actions selected for sustainable development.

Mission Objectives

- Building Human and Institutional capacities on climate change related aspects
- Network knowledge institutions and develop a coherent database on all knowledge systems
- Detect and decouple natural and anthropogenic global environmental changes and project future trends on potential impacts
- Assess the socio-economic and ecological consequences of global environmental change and design appropriate strategies for growth in the economy of the region

- Study traditional knowledge systems for community participation in adaptation, mitigation and coping mechanisms
- Evaluate policy alternatives for regional development plans
- Create awareness amongst stakeholders in the region
- Develop regional cooperation to generate a strong knowledge and database for policy interventions

19.6.6. NATIONAL MISSION FOR A GREEN INDIA

Mission Objectives

- Increased forest/tree cover on 5 million hectares (ha) of forest/non- forest lands and improved quality of forest cover on another 5 million ha of non-forest/forest lands (a total of 10 million ha)
- Improved ecosystem services including biodiversity, hydrological services, and carbon sequestration from the 10 million ha of forest/non-forest lands mentioned above
- Increased forest-based livelihood income of about 3 million households, living in and around the forests
- Enhanced annual CO2 sequestration by 50 to 60 million tones in the year 2020

Mission Targets

- Improvement in the quality of forest cover and ecosystem services of forests /nonforests, (including moderately dense, open forests, degraded grassland and wetlands: 5 million ha)
- Eco-restoration/afforestation of scrub, shifting cultivation areas, cold deserts, mangroves, ravines and abandoned mining areas (2 million ha)
- Improvement in forest and tree cover in urban/peri-urban lands (0.20 million ha)
- Improvement in forest and tree cover on marginal agricultural lands/fallows and other non-forest land under agro-forestry/social forestry (3 million ha)
- Management of public forest/non-forests areas (taken up under the mission) by community institutions
- Adoption of improved fuel wood-use efficiency and alternative energy devices by households in the project area
- Diversification of forest-based livelihoods of about 3 million households living in and around forests

Sub Missions

- Sub-mission 1: Enhancing quality of forest cover and improving ecosystem services (4.9 million ha)
- Sub-mission 2: Ecosystem restoration and increase in forest cover (1.8 million ha)
- Sub-mission 3: Enhancing tree cover in urban and peri-urban areas (including institutional lands): 0.20 million ha
- Sub-mission 4: Agro-forestry and social forestry (increasing biomass and creating carbon sink): 3 million ha
- Sub-mission 5: Restoration of wetlands: 0.10 million ha

Do you know?

Indian government has announced a domestic goal of reducing the carbon emission intensity by 20-25 per cent of its GDP of the 2005 level by 2020.

19.6.7. NATIONAL MISSION FOR SUSTAINABLE AGRICULTURE (NMSA)

Mission Objectives

- To devise strategic plans at the agro-climatic zone level so that action plans are contextualised to regional scales in the areas of research and development (R&D), technology and practices, infrastructure and capacity building
- To enhance agricultural productivity through customised interventions such as use of biotechnology to develop improved varieties of crops and livestock, promoting efficient irrigation systems, demonstration of appropriate technology, capacity building and skill development
- To facilitate access to information and institutional support by expanding Automatic Weather Station networks to the panchayat level and linking them to existing insurance mechanisms including the Weather Based Crop Insurance Scheme and the National Agriculture Insurance Scheme (NAIS), scaling the returns at that level
- To promote "laboratory to land" research by creating model villages and model farm units in rainfed and dryland areas

- To strategise long-term interventions for emission reduction from energy and non-energy uses by way of introduction of suitable crop varieties and farm practices, livestock and manure management
- To realise the enormous potential of growth in dryland agriculture, through the development of drought and pest resistant crop varieties, adopting resource-conserving technologies, providing institutional support to farmers and capacity building of stakeholders.
- The NMSA has identified 10 key dimensions for adaptation and mitigation:
  1. Improved Crop Seeds, Livestock and Fish Culture
  2. Water Efficiency
  3. Pest Management
  4. Improved Farm Practices
  5. Nutrient Management
  6. Agricultural Insurance
  7. Credit Support
  8. Markets
  9. Access to Information
  10. Livelihood Diversification

19.6.8. The National Mission on Strategic Knowledge for Climate Change (NMSKCC)

Mission Objectives

- Formation of knowledge networks among the existing knowledge institutions engaged in research and development relating to climate science and facilitating data sharing and exchange through a suitable policy framework and institutional support
- Establishment of global technology watch groups with institutional capacities to carry out research on risk minimised technology selection for developmental choices
- Development of national capacity for modeling the regional impact of climate change on different ecological zones within the country for different seasons and living standards
- Establishing research networks and encouraging research in the areas of climate change impacts on important socio-economic sectors like agriculture, health, natural ecosystems, biodiversity, coastal zones, etc.
- Generation and development of the conceptual and knowledge basis for defining sustainability of development pathways in the light of responsible climate change related actions
- Providing an improved understanding and awareness of key climate processes and the resultant climate risks and associated consequences
- To complement the efforts undertaken by other national missions, strengthen indigenous capacity for the development of appropriate technologies for responding to climate change through adaptation and mitigation and promote their utilisation by the government and societies for the sustainable growth of economies
- Creating institutional capacity for research infrastructure including access to relevant data sets, computing and communication facilities, and awareness to improve the quality and sector specific scenarios of climate change over the Indian subcontinent
- Ensuring the flow and generation of human resources through a variety of measures including incentives to attract young scientists to climate science
- Building alliances and partnerships through global collaboration in research & technology development on climate change under international and bilateral science and technology (S&T) cooperation arrangements

Do you know?

The concept of "green GDP" arose in the early 1990s in reaction to the deficiencies of the traditional gross domestic product (GDP) to account for the economic costs of depleted natural resources and incurred pollution, which in turn affect human welfare.

19.6.9. National Bio-Energy Mission

- The government is preparing a national bio-energy mission to boost power generation from biomass, a renewable energy source abundantly available in India.
- The mission, to be launched during the 12th Five-Year Plan, will offer a policy and regulatory environment to facilitate large-scale capital investments in biomass-fired power stations. It will also encourage development of rural enterprises.

- The national mission will aim at improving energy efficiency in traditional biomass consuming industries, seek to develop a bio-energy city project and provide logistics support to biomass processing units. It will also propose a GIS-based National Biomass Resource Atlas to map potential biomass regions in the country.
- According to estimates, biomass from agro and agro-industrial residue can potentially generate 25,000 MW of power in India. This can be further raised with wasteland-based integrated energy plantation and power generation systems.
- The bio-energy mission will adopt a two-phase approach, spanning the 12th Plan in Phase 1, and the 13th Plan in Phase 2.

Bio Energy

- "Bioenergy is renewable energy derived from biological sources, to be used for heat, electricity, or vehicle fuel. Biofuels derived from plant materials is among the most rapidly growing renewable energy technologies."

Sources of Bio – Energy

- Existing Sources
    - Leftover organic residue
    - Leftover farm organic residue
    - Leftover forest residue
    - Leftover organic urban residue
    - Algal residue
- New Sources
    - Cultivation of short rotation energy crops
    - Social forestry

Advantages of Bio – Energy

- Capital efficient
- High energy generation potential
- Significant carbon emission reduction potential
- Substantial employment and income generation potential
- Investments & benefits remain within the country
- Sizable economic value add to GDP
- Wasteland regeneration

Do you know?

India is highly vulnerable to climate change due to a combination of: (i) high levels of poverty, (ii) population density, (iii) high reliance on natural resources, and (iv) an environment already under stress (for instance water resources).

19.7. INDIAN NETWORK ON CLIMATE CHANGE ASSESSMENT

- The Indian Network on Climate Change Assessment (INCCA) was launched in October 2009 by the Ministry of Environment and Forests (MoEF) in an effort to promote domestic research on climate change, and build on the country's climate change expertise.
- INCCA is a network-based programme of the MoEF, which consists of over 120 institutions and over 250 scientists country wide is aimed at bringing in more science-based policy-making, based on measurements, monitoring and modelling.
- The INCCA has been conceptualized as a Network based Scientific Programme designed to address and assess the drivers and implications of climate change through scientific research; climate change assessments on various aspects of climate change, associated vulnerabilities and adaptation; devise decision support systems; and build capacity towards management of climate change related risks and opportunities.
- (The INCCA will carry out research on the effects of climate change in different regions and sectors in India and suggest suitable adaptation and mitigation steps.)
- Objective - to have an independent body of Indian scientists who could "prepare scientific reports at the domestic level about the impact of climate change on various sectors, which can give a real picture and influence the world debate".
- Reports prepared by the INCCA will form a part of India's National Communication (Nat Com) to the United Nations Framework Convention on Climate Change (UNFCCC).

19.7.1. INCCA – First Assessment 'India: Greenhouse Gas Emissions 2007'

- The first publication to come out from the INCCA has been an updated greenhouse gas emissions inventory for India for the year 2007.
- The first Assessment of the Green House Gas emissions was released on May 11, 2010.
- INCCA prepared the country's greenhouse gas (GHG) emission data "India: Greenhouse Gas Emissions 2007" which said the country's emissions grew by 58 per cent during 1994 to 2007

- It covers the sectors of Energy, Industry, Agriculture, Land Use Land Use Change and Forest and Waste by sources and removal by sinks presented in this document.

19.7.2. INCCA - Second Assessment 'Climate Change and India: A 4×4 Assessment'

- A 4×4 Assessment' addresses the impact of climate change in 2030s to the natural resources and livelihoods of the people in the four climate sensitive regions of Himalayan region, North-East region, the Western Ghats and the Coastal plains for the 4 key sectors of Agriculture, Water, Health and Natural Ecosystems and Biodiversity.
- The 4 region, 4 sectors Assessment in short has been referred to as a 4×4 Assessment.
- The assessment examines the implications of the climate change scenario in 2030s using a regional climate model (PRECIS).
- The assessment also brings out the future areas of work to enhance the knowledge and areas of further improvement in the future assessments.
- 4 Regions: Western Ghats, Himalayan Region, Coastal India, North-East
- 4 Thrust Areas: Agriculture, Water, Forests, Human Health

Impacts

- Warmer seasons: Avg. temp rise: 2.0 deg C predicted. 1.0-4.0 deg C at extreme ranges
- Increased annual precipitation with lower frequency of rainy days; increased intensity
- Cyclonic disturbances of lower frequency; increased intensity and increased risk of storm surges
- Sea-level rise: 1.3mm/year on average

Agriculture

- Up to 50% reduction in maize yields
- 4-35% reduction in rice yields (with some exceptions)
- Rise in coconut yields (with some exceptions); reduced apple production
- Negative impacts on livestock in all regions
- Fresh water supply
- High variability predicted in water yields (from 50% increase to 40-50% reduction)
- 10-30% increased risk of floods; increased risks of droughts

Forests and natural ecosystems

- Increased net primary productivity
- Shifting forest borders; species mix; negative impact on livelihoods and biodiversity

Human health

- Higher morbidity and mortality from heat stress and vector/water-borne diseases
- Expanded transmission window for malaria

Do you know?

Article 21 conferring the Right of Life has been assigned the broadest interpretations by the judiciary to encompass the right to a clean environment, right to livelihood, right to live with dignity and a number of other associated rights.

19.8. NATIONAL COMMUNICATION (NATCOM)

- In pursuance of the implementation of the provisions of the Convention, India's Initial National Communication (NATCOM) to the UNFCCC has been initiated in 2002 funded by the Global Environment Facility under its enabling activities programme through the United Nations Development Programme, New Delhi.

Parties to the Convention are enjoined to communicate the following information to the Secretariat of the Conference of Parties :

- A national inventory of anthropogenic emissions by sources and removal by sink of all GHGs not controlled by the Montreal protocol, to the extent its capacities, permit, using comparable methodologies to be promoted and agreed upon by the Conference of Parties.
- A general description of steps taken or envisaged by the Party to implement the Convention.
- Any other information relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication, including if feasible, material relevant for calculation of global emission trends.

- The National Communication process envisages comprehensive scientific and technical exercises for preparation of inventories of greenhouse gases of anthropogenic origin, reduction of uncertainities in these estimations and vulnerability assessment and adaptation due to climate change, besides other related information of India's initiatives which address the objectives of the Convention.

- Towards preparation of National Communication, a broad participatory approach involving research institutions, technical institutions, universities, government departments, and non governmental and private organizations has been adopted, necessitated by vast regional diversity and sector complexities in India.

Implementation arrangements

- The Ministry of Environment and Forests (MoEF) is implementing and executing agency of the project.

Work Programme envisaged

- Development of comprehensive inventory for the base year 1994 and improvement of its reliability vis-à-vis earlier estimates. This would entail reducing uncertainties of GHC emission coefficients in key source categories.
- Identification of key steps to be taken towards implementing the Convention.
- Vulnerabilty and adaptation assessment for presentation of information on specific needs and concerns arising from the adverse impacts of climate change.
- Creation of reliable and comprehensive database for all the outputs produced through the establishment of a 'Data Centre' (DC). This information will be accessible on the Internet.
- Enhancement of capacity to respond to projected climate change through the preparation of a 'Targeted Research Proposal' for developing a medium to long-term action plan.

GHG Inventory Estimations

- In accordance with the provisions of Article-4 and 12.1 of UNFCCC, preparation of inventories of a basket of gases has been started for the areas of energy, industrial processes, agriculture land use and land use change and forestry (LULUCF) and waste.
- The gases to be inventoried include carbon dioxide methane, nitrous oxide, hydrofluorocarbons, perfluorocarbon and sulphur hexafluoride released from various anthropogenic sources of the base year 1994.
- This is in addition to estimating historical trends of GHG growth as a part of the initial National Communication to UNFCCC.
- The estimation of national GHG inventories for all sectors is based on the 1996 guidelines of the 'Intergovernmental Panel on Climate Change' (IPCC) and as good practices guidelines.
- A network of institutions has been created for the preparation of GHG inventories.

Do you know?

Strengthening of ecological security is one of the goal of the Mahatma Gandhi Rural Employment Guarantee Programme (MGNREGA). MGNREGA is designed to strengthen ongoing efforts in the areas of water harvesting, watershed management and soil health care and enhancement.

19.4. INDIA'S POLICY STRUCTURE RELEVANT TO GHG MITIGATION

- Integrated Energy Policy
- India has in place a detailed policy, regulatory, and legislative structure that relates strongly to GHG mit-igation: The Integrated Energy Policy was adopted in 2006.
- Some of its key provisions are:
    - Promotion of energy efficiency in all sectors
    - Emphasis on mass transport
    - Emphasis on renewables including biofuels plantations
- Accelerated development of nuclear and hydropower for clean energy
- Focused R&D on several clean energy related technologies

1. **The Rural Electrification Policy, 2006**

- It promotes renewable energy technologies where grid connectivity is not possible or cost-effective. The New and Renewable Energy Policy, 2005, promotes utilization of sustainable, renewable energy sources, and accelerated deployment of renewables through indigenous design, development and manufacture.
- The National Environment Policy, 2006, and the Notification on Environment Impact Assessment (EIA), 2006, reform India's environmental assessment regime. A number of economic activities are required to prepare environment

impact assessments, and environment management plans, which are appraised by regulatory authorities prior to start of construction. The EIA provisions strongly promote environmental sustainability

Several other provisions

- It relates to reforming energy markets to ensure that energy markets are competitive, and energy prices reflect true resource costs. These include: Electricity Act 2005, Tariff Policy 2003, Petroleum & Natural Gas Regulatory Board Act, 2006, etc.
- The provisions taken together are designed to:
  - Remove entry barriers and raise competition in exploration, extraction, conversion, transmission and distribution of primary and secondary energy
  - Accomplish price reform, through full competition at point of sale
  - Promote tax reform to promote optimal fuel choices
  - Augment and diversify energy options, sources and energy infrastructure
  - Provide feed-in tariffs for renewables (solar, wind, biomass cogeneration)
  - Strengthen, and where applicable, introduce independent regulation

Do you know?

Rajiv Gandhi Environment Award for Clean Technology is given to industrial units that make a significant contribution towards the development of new or the innovative modification of existing technologies or adoption and use of clean technologies and practices that substantially reduce or prevent environmental pollution.

19.5. INTRODUCTION OF LABELLING PROGRAMME FOR APPLIANCES

- An energy labelling programme for appliances was launched in 2006, and comparative star-based labelling has been introduced for fluorescent tube-lights, air conditioners, refrigerators, and distribution transformers.
- The labels provide information about the energy consumption of an appliance, and thus enable consumers to make informed decisions. The Bureau of Energy Efficiency has made it mandatory for refrigerators to display energy efficiency label and is expected to do so for air conditioners as well. The standards and labelling programme for manufacturers of electrical appliances is expected to lead to significant savings in electricity annually.

Do you know?

The UN General Assembly on 23.01.95 adopted a resolution which proclaims 16th September as the International Day for the Preservation of the Ozone Layer, to commemorate the signing of the Montreal Protocol on the Substances that Deplete the Ozone Layer which was signed on 16th September, 1987

19.6. ENERGY CONSERVATION BUILDING CODE

- An Energy Conservation Building Code (ECBC) was launched in May, 2007, which addresses the design of new, large commercial buildings to optimize the buildings' energy demand based on their location in different climatic zones. Commercial buildings are one of the fastest growing sectors of the Indian economy, reflecting the increasing share of the services sector in the economy.
- Nearly one hundred buildings are already following the Code, and compliance with the Code has been incorporated into the mandatory Environmental Impact Assessment requirements for large buildings.
- It has been estimated that if all the commercial space in India every year conform to ECBC norms, energy consumption in this sector can be reduced by 30-40%.Compliance with ECBC norms is voluntary at present but is expected to soon become mandatory.

19.6.1. Green Building

- Buildings are one of the major pollutants that affect urban air quality and contribute to climate change.
- Human Habitats (Buildings) interact with the environment in various ways. Throughout their life cycles, from construction to operation and then demolition, they consume resources in the form of energy, water, materials, etc. and emit wastes either directly in the form of municipal wastes or indirectly as emissions from electricity generation.

- Green building is the essence of which would be to address all the pollution related issues of a building in an integrated and scientific manner.
- A green building depletes as little of the natural resources during its construction and operation.
- The aim of a green building design is to:
  - Minimize the demand on non-renewable resources and maximize the utilization efficiency of these resources when in use, and
  - Maximize reuse and recycling of available resources
  - Utilization of renewable resources.
- It costs a little more to design and construct a green building.
- However, it costs less to operate a green building that has tremendous environmental benefits and provides a better place for the occupants to live and work in.
- It maximizes the use of efficient building materials and construction practices; optimizes the use of on-site sources and sinks by bio-climatic architectural practices; uses minimum energy to power itself; uses efficient equipment to meet its lighting, air-conditioning, and other needs; maximizes the use of renewable sources of energy; uses efficient waste and water management practices; and provides comfortable and hygienic indoor working conditions.
- It is evolved through a design process that requires all concerned (the architect and landscape designer and the air conditioning, electrical, plumbing, and energy consultants) to work as a team to address all aspects of building and system planning, design, construction, and operation.
- They critically evaluate the impacts of each design decision on the environment and arrive at viable design solutions to minimize the negative impacts and enhance the positive impacts on the environment.
- In sum, the following aspects of the building design are looked into in an integrated way in a green building:
  - Building system designed in a way to efficiently use HVAC (heating ventilation and air conditioning), lighting, electrical, and water heating.
  - Integration of renewable energy sources to generate energy onsite.
  - Selection of ecologically sustainable materials (with high recycled content, rapidly renewable resources with low emission potential, etc.) for Water and waste management.
  - Indoor environmental quality (maintains indoor thermal and visual comfort and air quality)

Do you know?

The 42nd Amendment to the constitution brought about in the year 1974 inserted two new Articles namely,

Art. 48-A under Directive principles of State Policy, making it the responsibility of the State Government to protect and improve the environment and to safeguard the forests and wildlife of the country.

Art. 51-A (g) under Fundamental duties of citizens, making it the fundamental duty of every citizen to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures

19.6.2. Green Rating for Integrated Habitat Assessment (GRIHA)

- GRIHA is a Sanskrit word meaning – 'Abode'.
- GRIHA has been conceived by TERI and developed jointly with the Ministry of New and Renewable Energy, Government of India.
- The green building rating system devised by TERI and the MNRE is a voluntary scheme.

Objective

- The primary objective of the rating system is to help design green buildings and, in turn, help evaluate the 'greenness' of the buildings.

Aim

- The rating system aims to achieve efficient resource utilization, enhanced resource efficiency, and better quality of life in the buildings.

Rating Tool

- GRIHA is a rating tool that helps people assess the performance of their building against certain nationally acceptable benchmarks and is suitable for all kinds of buildings in different climatic zones of the country.

- ➢ Going by the old adage 'what gets measured, gets managed', GRIHA attempts to quantify aspects such as energy consumption, waste generation, renewable energy adoption, etc. so as to manage, control and reduce the same to the best possible extent.
- ➢ It will evaluate the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'.
- ➢ The rating system, based on accepted energy and environmental principles, will seek to strike a balance between the established practices and emerging concepts, both national and international.
- ➢ The guidelines/criteria appraisal may be revised every three years to take into account the latest scientific developments during this period.

The basic features

- ➢ The system has been developed to help 'design and evaluate' new buildings (buildings that are still at the inception stages).
- ➢ A building is assessed based on its predicted performance over its entire life cycle – inception through operation.
- ➢ The stages of the life cycle that have been identified for evaluation are:
  - Pre-construction stage (intra- and inter-site issues like proximity to public transport, type of soil, kind of land, where the property is located, the flora and fauna on the land before construction activity starts, the natural landscape and land features)
  - Building planning and construction stages (issues of resource conservation and reduction in resource demand, resource utilization efficiency, resource recovery and reuse, and provisions for occupant health and well being). The prime resources that are considered in this section are land, water, energy, air, and green cover.
  - Building operation and maintenance stage (issues of operation and maintenance of building systems and processes, monitoring and recording of energy consumption, and occupant health and well being, and also issues that affect the global and local environment).

Rating system

- ➢ GRIHA rating system consists of 34 criteria categorized under 4 categories.
- ➢ They are
  1. Site Selection and Site Planning,
  2. Conservation and efficient utilization of resources,
  3. Building operation and maintenance, and
  4. Innovation points.
- ➢ Eight of these 34 criteria are mandatory, four are partly mandatory, while the rest are optional. Each criterion has a number of points assigned to it.
- ➢ It means that a project intending to meet the criterion would qualify for the points. Different levels of certification (one star to five stars) are awarded based on the number of points earned. The minimum points required for certification is 50.

Do you know?

Medini Puraskar Yojana - This award is given to Indian authors each year to encourage original works in Hindi on environment and its related subjects such as wildlife, water resources and conservation

The benefits

- ➢ On a broader scale, this system, along with the activities and processes that lead up to it, will benefit the community at large with the improvement in the environment by reducing GHG (greenhouse gas) emissions, reducing energy consumption and the stress on natural resources.
- ➢ Some of the benefits of a green design to a building owner, user, and the society as a whole are as follows:
  - Reduced energy consumption without sacrificing the comfort levels
  - Reduced destruction of natural areas, habitats, and biodiversity, and reduced soil loss from erosion etc.
  - Reduced air and water pollution (with direct health benefits)
  - Reduced water consumption
  - Limited waste generation due to recycling and reuse

- Reduced pollution loads
- Increased user productivity
- Enhanced image and marketability

The challenges

- ➢ The Indian building industry is highly decentralized with people and/ or groups engaged in design, construction, equipment provision, installation, and renovation working together.
- ➢ Each group may be organized to some extent, but there is limited interaction among the groups, thus disabling the integrated green design and application process.
- ➢ Hence, it is very important to define and quantify sustainable building practices and their benefits.
- ➢ It is also important to separate the role of different participants in ensuring that the building consumes minimal resources over its entire life cycle and leaves behind a minimal environmental footprint.
- ➢ It has derived useful inputs from the upcoming mandatory voluntary building codes/guidelines being developed by the Bureau of Energy Efficiency, the Ministry of Non-Conventional Energy Sources, MoEF (Ministry of Environment and Forests), Government of India, and the Bureau of Indian Standards.

Do you know?

Amrita Devi Bishnoi Wildlife Protection Award is given for significant contribution in the field of wildlife protection, which is recognised as having shown exemplary courage or having done exemplary work for the protection of wildlife.

19.7. ENERGY AUDITS OF LARGE INDUSTRIAL CONSUMERS

- ➢ In March 2007 the conduct of energy audits was made mandatory in large energy-consuming units in nine industrial sectors. These units, notified as "designated consumers" are also required to employ "certified energy managers", and report energy consumption and energy conservation data annually.

19.8. MASS TRANSPORT

- ➢ The National Urban Transport Policy emphasizes extensive public transport facilities and non-motorized modes over personal vehicles. The expansion of the Metro Rail Transportation System in Delhi and other cities (Chennai, Bangalore, Jaipur, etc) and other mass transit systems, such as the Metro Bus project in Bangalore, are steps in its implementation. The state government of Maharashtra recently announced that it will impose a congestion tax to discourage the use of private cars in cities where it has created "sufficient public transport capacity".

Do you know?

Rajiv Gandhi Wildlife Conservation Award is Awarded annually for significant contribution in the field of wildlife conservation which has made or has the potential to make, a major impact on the protection and conservation of wildlife in the country

19.9. CLEAN AIR INITIATIVES

- ➢ In urban areas, one of the major sources of air pollution is emissions from transport vehicles.
- ➢ Steps taken to reduce such pollution include
  - (i) introduction of compressed natural gas (CNG) in Delhi and other cities;
  - (ii) Retiring old, polluting vehicles; and
  - (iii) Strengthening of mass transportation.
- ➢ Some state governments provide subsidies for purchase and use of electric vehicles. For thermal power plants, the installation of electrostatic precipitators is mandatory. In many cities, polluting industrial units have either been closed or shifted from residential areas.

19.10. PROMOTION OF ENERGY SAVING DEVICES

- ➢ The Bureau of Energy efficiency has introduced "The Bachat Lamp Yojana", a programme under which households may exchange incandescent lamps for CFLs (compact fluorescent lamps) using clean development mechanism (CDM) credits to equate purchase price.
- ➢ Some states have made mandatory the installation of solar water heaters in hospitals, hotels and large government and commercial buildings. Subsidy is provided for installation of solar water heaters in residential buildings.

19.11.PROMOTION OF BIOFUELS

- The Biodiesel Purchase Policy mandates biodiesel procurement by the petroleum industry. A mandate on Ethanol Blending of Gasoline requires 5% blending of ethanol with gasoline from 1st January, 2003, in 9 States and 4 Union Territories.

Do you know?

Indira Gandhi Paryavaran Puraskar is Awarded each year to Indian nationals or any Indian organisation for significant contributions in the field of environment.

19.12.INDIAN SOLAR LOAN PROGRAMME

- In April 2003, the United Nations Environment Programme ("UNEP") initiated a, three-year Programme, credit facility in Southern India to help rural households finance the purchase of Solar Home Systems.
- Canara Bank and Syndicate Bank, along with their eight associate Regional Rural Banks, partnered with UNEP to establish and run a Loan Programme through their branch offices across Karnataka State and part of the neighbouring Kerala State.
- In addition to providing financial support in the form of interest rate subsidies for borrowers, UNEP provides assistance with technical issues, vendor qualification and other activities to develop the institutional capacity for this type of finance.

19.13.NATIONAL INITIATIVE ON CLIMATE RESILIENT AGRICULTURE (NICRA)

- The ICAR has launched National Initiative on Climate Resilient Agriculture (NICRA) during 2010-11 with an outlay of Rs.350 crores for the XI Plan.
- This initiative will primarily enhance the resilience of Indian Agriculture covering crops, livestock and fisheries.

19.13.1.Objectives

- To enhance the resilience of Indian agriculture covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies
- To demonstrate site specific technology packages on farmers' fields for adapting to current climate risks
- To enhance the capacity building of scientists and other stakeholders in climate resilient agricultural research and its application.

Project Components

- Both short term and long terms outputs are expected from the project in terms of new and improved varieties of crops, livestock breeds, management practices that help in adaptation and mitigation and inputs for policy making to mainstream climate resilient agriculture in the developmental planning. The overall expected outcome is enhanced resilience of agricultural production to climate variability in vulnerable regions.
- The project is comprised of four components.
  1) Strategic research on adaptation and mitigation
  2) Technology demonstration on farmers' fields to cope with current climate variability
  3) Sponsored and competitive research grants to fill critical research gaps
  4) Capacity building of different stake holders

Strategic Research

- The strategic research has been planned at leading research institutes of ICAR in a network mode covering crops, horticulture, livestock, natural resource management and fisheries sectors.
- To begin with, the project is focusing on crops like wheat, rice, maize, pigeonpea, groundnut, tomato, mango and banana; cattle, buffalo and small ruminants among livestock and both marine and freshwater fish species of economic importance.
- The major research themes are:
  - Vulnerability assessment of major production zones
  - Linking weather based agro-advisories to contingency planning
  - Assessing the impacts and evolving varieties tolerant to key climatic stresses (drought, heat, frost, flooding, etc.) in major food and horticulture crops

- Continuous monitoring of greenhouse gases in open field conditions in major production systems
- Evolving adaptation and mitigation strategies through enhancing water and nutrient use efficiency and conservation agriculture
- Studying changes in pest dynamics, pest/pathogen-crop relationships and emergence of new pests and pathogens under changing climate
- Adaptation strategies in livestock through nutritional and environmental manipulations
- Harnessing the beneficial effects of temperature in inland and marine fisheries through better understanding of the spawning behaviour.

➢ Seven major research institutes of the ICAR will work in unison to evolve coping technologies with Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad as the lead centre.

➢ Best-bet and cost-effective technologies to cope with climate variability will be demonstrated on farmers' fields in 100 most vulnerable districts of the country.

➢ The technologies include rain water harvesting and its judicious use, in-situ moisture conservation, drought management strategies, seed and fodder banks, timely and precision agriculture, effective agro-advisory system using Information Communication Technology kiosks.

➢ Small and marginal farmers in rain-fed, coastal and hill areas will benefit more in view of the focused attention in these regions.

➢ Capacity building of scientists in frontier areas is another core activity of the project.

➢ To prepare all stakeholders to face challenges, multi-pronged awareness generation programs on issues of climate change are planned.

19.14.BSE-GREENEX

➢ The BSE-GREENEX Index is a veritable first step in creating a credible market based response mechanism in India, whereby both businesses and investors can rely upon purely quantitative and objective performance based signals, to assess "carbon performance".

➢ gTrade Carbon Ex Ratings Services Private Limited (gTrade) is a company based in India, which has co-developed the BSE-GREENEX Index in close association with the BSE.

Index Description

➢ The BSE-GREENEX Index includes the top 20 companies which are good in terms of Carbon Emissions, Free-Float Market Capitalization and Turnover.

➢ The Index is a Cap Weighted Free-Float Market Capitalization weighted Index comprising from the list of BSE-100 Index.

➢ The Index has been back-tested from 1stOctober, 2008 (Base Date) with the base index value of 1000.

➢ The Index is rebalanced on a bi-annual basis i.e. end of March and September quarters.

➢ The September quarter review will be based on the fresh set of carbon emission numbers and the March quarter review will be based on the existing carbon emission numbers but latest financial data.

Do you know?

➢ Clean Development Mechanism Activity is officially divided into the following sectors:

1. Energy industries (renewable-/non-renewable sources);
2. Energy distribution;
3. Energy demand;
4. Manufacturing industries;
5. Chemical industries;
6. Construction;
7. Transport;
8. Mining/mineral production;
9. Metal production;
10. Fugitive emissions from fuels (solid, oil and gas);
11. Fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride;
12. Solvent use;
13. Waste handling and disposal;
14. Afforestation and reforestation;
15. Agriculture.

19.15. 24 OTHER "CRITICAL INITIATIVES"

- In addition, India has 24 other "Critical Initiatives" in the anvil, for which detailed plans and an institutional framework is being prepared

Type	Initiative
Energy Efficiency in Power Generation	Super critical technologies Integrated Gasification Combined Cycle (IGCC)
Technology	Natural Gas based Power Plants Closed Cycle Three Stage Nuclear Power Programme Efficient Transmission and Distribution Hydropower
Other Renewable Energy Technologies Programmes	RETs for power generation Biomass based popup generation technologies Small scale Hydropower Wind Energy Grid connected systems RETs for transportation and industrial fuels
Disaster Management Response to Extreme Climate Events	Reducing risk to infrastructure through better design Strengthening communication networks and disaster management facilities
Protection of Coastal Areas	Undertake measures for coastal protection and setting up Early Warning System Development of a regional ocean modelling system High resolution coupled ocean-atmosphere variability studies in tropical oceans Development of a high-resolution storm surge model for coastal regions Development of salinity-tolerant crop cultivars Community awareness on coastal disasters and necessary action; Timely forecasting, cyclone and flood warning systems Enhanced plantation and regeneration of mangroves and coastal forests
Health Sector	Provision of enhanced public health care services and assessment of increased burden of disease due to climate change
Creating appropriate capacity at different levels of Government	Building capacity in the Central, State and other at the local level to assimilate and facilitate the implementation of the activities of national plan

◆◆◆◆◆◆

CHAPTER - 20

CLIMATE CHANGE ORGANIZATIONS

20.1. UNFCCC

- UN Summit Conference on Environment and Development (UNCED) held in Rio de Janerio in June 1992 adopted, by consensus, the first multilateral legal instrument on Climate Change, the UN Framework Convention on Climate Change or the UNFCCC.
- In 1992, countries joined UNFCCC, to cooperatively consider what they could do to limit average global temperature increases and the resulting climate change, and to cope with whatever impacts were, by then, inevitable. There are now 195 Parties to the Convention.
- The UNFCCC secretariat supports all institutions involved in the international climate change negotiations, particularly the Conference of the Parties (COP), the subsidiary bodies (which advise the COP), and the COP Bureau (which deals mainly with procedural and organizational issues arising from the COP and also has technical functions).
- All subsequent multilateral negotiations on different aspects of climate change, including both adaptation and mitigation, are being held based on the principles and objectives set out by the UNFCCC.

Do you know?

The major difference Tortoise vs turtle being that the land dwelling ones are called Tortoises and water dwelling are called Turtles. Tortoise are herbivorous where as turtle are omnivorous

20.2. KYOTO PROTOCOL: COP-3.

- By 1995, countries realized that emission reductions provisions in the Convention were inadequate. They launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol.
- The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997. Due to a complex ratification process, it entered into force on 16 February 2005.
- In short, the Kyoto Protocol is what "operationalizes" the Convention. It commits industrialized countries to stabilize greenhouse gas emissions based on the principles of the Convention.
- The major distinction between the Protocol and the Convention is that while the Convention encouraged industrialized countries to stabilize GHG emissions, the Protocol commits them to do so.

20.2.1. Targets

- KP, as it is referred to in short, sets binding emission reduction targets for 37 industrialized countries and the European community in its first commitment period.
- It only binds developed countries because it recognizes that they are largely responsible for the current high levels of GHG emissions in the atmosphere, which are the result of more than 150 years of industrial activity.
- KP places a heavier burden on developed nations under its central principle: that of "common but differentiated responsibility".
- Overall, these targets add up to an average five per cent emissions reduction compared to 1990 levels over the five-year period 2008 to 2012.

The architecture of the KP regime: What makes KP tick?

- The Kyoto Protocol is made up of essential architecture that has been built and shaped over almost two decades of experience, hard work and political will. The beating heart of KP is made up of:
    1. Reporting and verification procedures;
    2. Flexible market-based mechanisms, which in turn have their own governance procedures; and
    3. A compliance system.
- So, two things make KP tick.

1. Emissions Reduction Commitments

- The first was binding emissions reduction commitments for developed country parties. This meant the space to pollute was limited.
- Greenhouse gas emissions, most prevalently carbon dioxide, became a new commodity. KP now began to internalize what was now recognized as an unpriced externality.

Do you know?

Indian Water Monitor lizard is one of the largest as well as the heaviest species of lizards, second only to the Komodo Monitors

2. Flexible Market Mechanisms

- This leads us to the second, the flexible market mechanisms of the KP, based on the trade of emissions permits. KP countries bound to targets have to meet them largely through domestic action— that is, to reduce their emissions onshore.
- But they can meet part of their targets through three "market-based mechanisms" that ideally encourage GHG abatement to start where it is most cost-effective-- for example, in the developing world. Quite simply, it does not matter where emissions are reduced, as long as they are removed from the planet's atmosphere.
- The Kyoto Flexible Market Protocol mechanisms:
  - Joint Implementation (JI)
  - The Clean Development Mechanism (CDM)
  - Emission Trading

20.2.2. The objectives of Kyoto mechanisms:

- Its objective is to facilitate, promote and enforce compliance with the commitments under the Protocol.
  - Stimulate sustainable development through technology transfer and investment
  - Help countries with Kyoto commitments to meet their targets by reducing emissions or removing carbon from the atmosphere in other countries in a cost-effective way
  - Encourage the private sector and developing countries to contribute to emission reduction efforts

Joint Implementation:

- The mechanism known as "joint implementation", allows a country with an emission reduction or limitation commitment under the Kyoto Protocol (Annex B Party – developed country) to earn emission reduction units (ERUs) from an emission-reduction or emission removal project in another Annex B Party, each equivalent to one tonne of CO2, which can be counted towards meeting its Kyoto target.
  - Joint implementation offers Parties a flexible and cost-efficient means of fulfilling a part of their Kyoto commitments, while the host Party benefits from foreign investment and technology transfer.
  - Projects starting as from the year 2000 may be eligible as JI projects, ERU issued from 2008

Clean Development mechanism:

- The Clean Development Mechanism (CDM) allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries.
- It is the first global, environmental investment and credit scheme of its kind, providing standardized emissions offset instrument, CERs
- Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO2, which can be counted towards meeting Kyoto targets.

Example

- A CDM project activity might involve, for example, a rural electrification project using solar panels or the installation of more energy-efficient boilers. The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction or limitation targets.
- Most of the CDM projects were implemented in China and India as climate in these countries is favorable for implementing projects for almost all the spheres such as Agriculture, Waste handling and disposal, Afforestation and reforestation. Such CDM projects are also to be supported by the approval of Annex B countries - those which have quantified obligations according Kyoto Protocol.

Carbon Trading:

- Carbon trading is the name given to the exchange of emission permits. This exchange may take place within the economy or may take the form of international transaction.
- Two types of Carbon trading:
  1. Emission trading and
  2. Offset trading.

Emission trading/ 'cap-and-trade',

- Emission permit is known alternatively as carbon credit. For each Annex I country, the protocol has assigned a fixed amount of carbon emission in the agreement. This amount is actually the amount of emission which is to be reduced by the concerned country.
- On the other hand, it implies that the country was permitted to emit the remaining amount. This emission allowance is actually one kind of carbon credit.
- The total amount of allowance is then subdivided into certain units. The units are expressed in terms of carbon-equivalent. Each unit gives the owner the right to emit one metric tonne of carbon dioxide or other equivalent green-house gases.

Offset Trading/ Carbon Project/ 'baseline-and credit' trading:

- Another variant of carbon credit is to be earned by a country by investing some amount of money in such projects, known as carbon projects, which will emit lesser amount of greenhouse gas in the atmosphere.
- For example, suppose a thermal plant of 800 megawatt capacity emit 400 carbon-equivalent in the atmosphere. Now a country builds up a 800 megawatt wind energy plant which does not generate any amount of emission as an alternative of the thermal plant. Then by investing in this project the country will earn 400 carbon-equivalent.
- According to an estimate made by the World Bank's Carbon Finance Unit, volume of carbon trade through Emission Trading route alone had shown a 240 percent increase in 2005 over the previous year.

Benefits of Flexible Market Mechanisms

- This has the parallel benefits of stimulating green investment in developing countries and of including the private sector in this endeavour to cut and hold steady GHG emissions at a safe level.
- It also makes "leap-frogging" more economical that is, the possibility to skip older, dirtier technology for newer, cleaner infrastructure and systems, with obvious longer-term benefits.
- The Kyoto Protocol compliance mechanism is designed to strengthen the Protocol's environmental integrity, support the carbon market's credibility and ensure transparency of accounting by Parties.

Do you know?

One of the unique features of the Rock pythons of India is that they can raise their body temperature above the ambient level, through muscular contractions. Rock python of India is an endangered species. The reason for this is that it is killed for its fine skin, meat and even for medicinal purposes.

20.2.4. Non-Compliance of Kyoto And Penalties

- Like most things in life, failure to comply with the Protocol carries penalties.
- If a country does not meet the requirements for measurements and reporting said country looses the privilege of gaining credit through joint implementation projects.
- If a country goes above its emissions cap, and does not try to make up the difference through any of the mechanisms available, then said country must make up the difference plus an additional thirty percent during the next period.
- The country could also be banned from participating in the 'cap and trade' program.

20.3. BALI MEET:

- Bali Meet was the meeting of 190 countries that are party to a UN treaty on climate change held in December 2007.

Objectives:

- The treaty's aim was to push the world towards taking action that reduces the greenhouse gases in the atmosphere which cause climate change.
- Bali was to discuss what happens after 2012—what are countries expected to do after the first phase of Kyoto ends in 2012.

- As per developed countries, after 2012, even the developing countries like India and China, which are increasing their emissions as they grow economically, also undertake some kind of emission cuts. This meant a complete overhaul of the existing UN treaty.
- In Bali, the nations have decided upon a new set of principles that will, help the countries decide a post-2012 deal.

20.3.1. Bali Roadmap

- The participating nations adopted the Bali Road Map as a two-year process to finalizing a binding agreement in 2009 in Copenhagen.
- The Bali Road Map includes;
  - The Bali Action Plan (BAP)
  - The Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol negotiations and their 2009 deadline,
  - Launch of the Adaptation Fund,
  - Decisions on technology transfer and
  - On reducing emissions from deforestation.

20.3.2. Bali Action Plan

- The Conference of Parties decided to launch a comprehensive process to enable the implementation of the Convention through long-term cooperative action up to and beyond 2012, by addressing:
  - A shared vision for long-term cooperative action, including a long-term global goal for emission reductions.
  - Enhanced national/international action on mitigation of climate change.
  - Enhanced action on adaptation.
  - Enhanced action on technology development and transfer to support action on mitigation and adaptation.
  - Enhanced action on the provision of financial resources and investment to support action on mitigation and adaptation and technology cooperation.

Do you know?

Russell's Viper is responsible for the more deaths due to snakebite than any other venomous snake. It is highly irritable and when threatened, coils tightly, hisses, and strikes with a lightning speed. Its hemotoxic venom is a very potent coagulant, which damages tissue as well as blood cells.

20.4. COP 15 COPENHAGEN SUMMIT:

- A legally binding agreement could not be arrived n CoP 15, Copenhagen mainly due to discord between developing and developed nations.
- The summit concluded with the CoP taking a note of Copenhagen Accord (a five nation accord- BASIC and US).
- The Copenhagen Accord is a non-binding agreement.
- The Accord states that deep international emissions cuts are needed to hold the increase in global temperature to under two degrees Celsius.
- Under the Accord, developed countries (Annex I) agree to set targets for reductions in their greenhouse gas emissions by 2020.
- Developing countries agree to pursue nationally appropriate mitigation strategies to slow the growth of their emissions, but are not committed to reducing their carbon output.
  - Recognizes the need to establish a mechanism (including REDD-plus) to enable the mobilization of financial resources from developed countries to help achieve this
  - Developing countries, specially these with low-emitting economies should be provided incentives to continue to develop on a low-emission pathway
  - Agrees that developed countries would raise funds of $30 billion from 2010-2012 of new and additional resources
  - Agrees a "goal" for the world to raise $100 billion per year by 2020. New multilateral funding for adaptation will be delivered, with a governance structure.

20.5. COP 16 CANCUN SUMMIT

- The Cancun Agreements include decisions under both the Convention and Kyoto protocol negotiating tracks.
- As per the Cancun Agreements, all Parties to the Convention (including the developed and developing countries) have agreed to report their voluntary mitigation goals for implementation.
- These will be subject to measurement and verification or international consultation, as appropriate, in accordance with agreed international guidelines.

- Decisions were taken at Cancun to set up a Green Climate Fund, a Technology Mechanism, and an Adaptation Committee at global level to support developing country actions for adaptation and mitigation.
- These decisions are significant because they reflect, to a large degree, the political understanding that was reached by a select group of countries in the form of the Copenhagen Accord in December 2009.

20.5.1. Cancun Agreements

- Industrialized country targets are officially recognized under the multilateral process and these countries are to develop low-carbon development plans and strategies and assess how best to meet them, including through market mechanisms, and to report their inventories annually.
- Developing country actions to reduce emissions are officially recognized under the multilateral process. A registry is to be set up to record and match developing country mitigation actions to finance and technology support from by industrialized countries. Developing countries are to publish progress reports every two years.
- A total of $30 billion in fast start finance from industrialized countries to support climate action in the developing world up to 2012 and the intention to raise $100 billion in long-term funds by 2020 are included in the decisions.
- In the field of climate finance, a process to design a 'Green Climate Fund' under the Conference of the Parties, with a Board with equal representation from developed and developing countries, is established.
- A new Cancun Adaptation Framework is established to allow better planning and implementation of adaptation projects in developing countries through increased financial and technical support, including a clear process for continuing work on loss and damage.
- Governments agree to boost action to curb emissions from deforestation and forest degradation in developing countries with technological and financial support.
- Parties have established a technology mechanism with a Technology Executive Committee and Climate Technology Centre and Network to increase technology cooperation to support action on adaptation and mitigation.

20.5.2. Mechanism of COP 16

- Three mechanisms that are outcome of CoP 16 are
  1. Technology mechanism
  2. Green climate fund
  3. Adaptation committee

Technology Mechanism

- A Technology Mechanism, under the guidance of and accountable to the Conference of the Parties (COP), was established by the 16th session of the COP in Cancun 2010.
- The Technology Mechanism is expected to facilitate the implementation of enhanced action on technology development and transfer in order to support action on mitigation and adaptation to climate change.

Green Climate Fund

- At COP 16, Parties, established a Green Climate Fund (GCF) as an operating entity of the financial mechanism of the Convention under Article 11.
- The GCF will support projects, programmes, policies and other activities in developing country Parties. The Fund will be governed by the GCF Board.
- The assets of the GCF will be administered by a trustee only for the purpose of, and in accordance with, the relevant decisions of the GCF Board.
- The World Bank was invited by the COP to serve as the interim trustee of the GCF, subject to a review three years after operationalization of the Fund.
- The COP also decided that an independent secretariat will support the operations of the Fund. The COP also decided that the GCF was to be designed by the Transitional Committee (TC).

Do you know?

At the time of nesting, the female hornbill starts living in a tree hollow sealed with dung and pellets of mud. The male collects the pellets, swallows them and regurgitates small saliva-cased building materials. This material is given to the female, along with food, through a slit in the tree seal. The process of incubation continues for 6-8 weeks. The female hornbill comes out only after she has molted and fresh feathers have grown on her and her young ones.

Update

- ➢ At COP 17 held in Durban, in which Parties approved the governing instrument for the GCF. Arrangements between the COP and the Fund are to be concluded at COP 18 to ensure that it is accountable to and functions under the guidance of the COP.
- ➢ The COP will provide guidance to the Board, including on matters related to policies, programme priorities and eligibility criteria and matters related thereto. The Board will provide annual reports to the COP on its activities.

Adaptation Fund

- ➢ The Adaptation Fund was established to finance concrete adaptation projects and programmes in developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change.
- ➢ The Adaptation Fund is financed from the share of proceeds on the clean development mechanism project activities and other sources of funding. The share of proceeds amounts to 2% of certified emission reductions (CERs) issued for a CDM project activity.
- ➢ The Adaptation Fund is supervised and managed by the Adaptation Fund Board (AFB). The AFB is composed of 16 members and 16 alternates and meets at least twice a year.
- ➢ Upon invitation from Parties, the Global Environment Facility (GEF) provides secretariat services to the AFB and the World Bank serves as trustee of the Adaptation Fund, both on an interim basis.

Do you know?

The only endemic genus in the hotspot is the Namadapha flying squirrel which is critically endangered and is described only from a single specimen from Namdapha National Park

Adaptation Committee

- ➢ As part of the Cancun Adaptation Framework, Parties established the Adaptation Committee to promote the implementation of enhanced action on adaptation in a coherent manner under the Convention through the following functions:
  - I. Providing technical support and guidance to the Parties
  - II. Sharing of relevant information, knowledge, experience and good practices
  - III. Promoting synergy and strengthening engagement with national, regional and international organizations, centres and networks
  - IV. Providing information and recommendations, drawing on adaptation good practices, for consideration by the COP when providing guidance on means to incentivize the implementation of adaptation actions, including finance, technology and capacity-building
  - V. Considering information communicated by Parties on their monitoring and review of adaptation actions, support provided and received

20.6. COP 17 DURBAN SUMMIT

- Firm India forces climate breakthrough at Durban
- Principle of Equity Must In Future Talks

New global climate change regime

- ➢ India had gone to Durban with two major demands — that the principle of equity remain intact in any new climate regime and that this new global deal be launched after 2020.

Outcome

- New deal to be finalized by 2015 and launched by 2020
- Second phase of Kyoto Protocol secured
- Green Climate Fund launched, though empty as yet Green tech development mechanism put in place
- Equity finds place back in future climate talks
- Adaptation mechanism
- Transparency mechanism

Geopolitical Fallout

- ➢ India regains leadership of developing world. EU gains heft at cost of US but also generates bad relations with developing countries. Small island states lose respect by becoming EU front.
- ➢ BASIC grouping looks more fragile than before with India and China remaining close but Brazil and South Africa drifting.

India's Gains And Losses

- ➢ Wins on all its important non-negotiables Common but differentiated responsibility principle retained.

- Secures 10 years of economic growth without carbon containment Intellectual Property Rights and technology not as well anchored in new deal
- Loopholes for developed world not fully blocked
- Agriculture brought in by developed nations under climate change

Agenda Ahead For India

- Fight to deploy principle of equity in practice in a new deal
- Ensure that review of existing commitments of developed world is mandated
- Ensure Kyoto Protocol's second phase from 2012-2017 takes off
- Negotiate for 5 yrs the hard talks that will set out terms of new global regime

> **Do you know?**
>
> The Relict Dragonfly (Epiophlebia laidlawi) is an endangered species found here with the only other species in the genus being found in Japan. The region is also home to the Himalayan Newt the only salamander species found within Indian limits.

20.7. OTHER MECHANISMS OF UNFCCC

1. Special Climate Change Fund (Sccf)

- The Special Climate Change Fund (SCCF) was established under the Convention in 2001 to finance projects relating to: adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification.
- The Global Environment Facility (GEF), as an operating entity of the financial mechanism, has been entrusted to operate the SCCF.

2. Finance Mechanism for Climate Change

- The Financial resources that have been made available to Non-Annex I Parties to the UNFCCC consist of the following three modules:
  - **The "National Communications Module":** This module presents information communicated by Annex II Parties on the provision of financial resources related to the implementation of the Convention through their fourth and fifth national communications.

Fast-Start Finance

- During the Conference of the Parties (COP15) held in December 2009 in Copenhagen developed countries pledged to provide new and additional resources, including forestry and investments, approaching USD 30 billion for the period 2010 - 2012 and with balanced allocation between mitigation and adaptation. This collective commitment has come to be known as 'fast-start finance'.
- Following up on this pledge, the Conference of the Parties (COP 16)in Cancún, in December 2010, took note of this collective commitment by developed country Parties and reaffirmed that funding for adaptation will be prioritized for the most vulnerable developing countries, such as the least developed countries, small island developing States and Africa.
- At COP 17 Parties welcomed the fast-start finance provided by developed countries as part of their collective commitment to provide new and additional resources approaching USD 30 billion for the period 2010–2012, and noted the information provided by developed country Parties on the fast-start finance they have provided and urged them to continue to enhance the transparency of their reporting on the fulfillment of their fast-start finance commitments.
- **The "Funds Managed by the GEF Module"** is a joint effort between the secretariat of the UNFCCC and the secretariat of the Global Environment Facility (GEF). This module presents information on financial flows that have been channelled, mobilized and leveraged by the GEF in its role as an operating entity of the Financial Mechanism of the UNFCCC.

20.8. REDD & REDD+

- REDD (Reducing Emissions from Deforestation and Forest Degradation) is the global endeavour to create an incentive for developing countries to protect, better manage and save their forest resources, thus contributing to the global fight against climate change
  - REDD+ goes beyond merely checking deforestation and forest degradation, and

includes incentives for positive elements of conservation, sustainable management of forests and enhancement of forest carbon stocks.

- REDD+ conceptualizes flow of positive incentives for demonstrated reduction in deforestation or for enhancing quality and expanse of forest cover.
- It works on the basis of creating a financial value for the carbon stored and enhanced in biomass and soil of standing forests. Countries that reduce emissions and undertake sustainable management of forests will be entitled to receive funds and resources as incentives.
- REDD+ approach incorporates important benefits of livelihoods improvement, biodiversity conservation and food security services.

Will India Benefit from REDD+?

India's sustained efforts for conserving and expanding its forest and tree resources have the possibility of being rewarded for providing carbon service to the international community in addition to providing traditional goods and services to the local communities.

➢ The incentives so received from REDD+ would be passed to the local communities involved in protection and management of the forests. This will ensure sustained protection of our forests against deforestation.

➢ It is estimated that a REDD+ programme for India could provide capture of more than 1 billion tonnes of additional CO2 over the next 3 decades and provide more than USD 3 billion as carbon service incentives under REDD+.

India's Position on Redd And Redd+

➢ India believes REDD needs to be seen in the broader context of REDD+, not in isolation or in a truncated form since reduction of deforestation, and conservation and improvement of forests are two sides of the same coin, and so should be treated at par.

➢ India's stand was finally accepted in 13th Meeting of the Conference of the Parties (COP 13) at Bali when elements of conservation, sustainable management of forests and enhancement of forest carbon stocks were added to the then existing text of reducing deforestation and forest degradation as part of Bali Action Plan.

➢ It has presented an ambitious Green India Mission programme under its National Action Plan on Climate Change.

India initiatives related to REDD+

➢ India has made a submission to UNFCCC on "REDD, Sustainable Management of Forest(SMF) and Afforestation and Reforestation (A&R)" in December 2008

➢ A Technical Group has been set up to develop methodologies and procedures to assess and

➢ monitor contribution of REDD+ actions

➢ A National REDD+ Coordinating Agency is being established

➢ A National Forest Carbon Accounting Programme is being institutionalized

➢ India is hosting the Conference of Parties (COP-11) of the Convention on Biological Diversity (CBD) in 2012, to coincide with twenty years of Rio convention.

➢ Study on the impact of climate change on India's forests assigned to the Indian Network for Climate Change Assessment (INCCA), has been released in November 2010.

➢ There is likely to be an increase in Net Primary Productivity (NPP) ranging from 20 – 57 %.

India looks for Enhanced Implementation of the Unfccc

India looks forward to enhanced international cooperation under the UNFCCC. Overall, future international cooperation on climate change should address the following objectives:

➢ Minimizing the negative impacts of climate change through suitable adaptation measures in the countries and communities affected and mitigation at the global level

➢ Provide fairness and equity in the actions and measures

➢ Uphold the principle of common but differentiated responsibilities in actions to be taken, such as concessional financial flows from the developed countries, and access to technology on affordable terms

➢ India as a large democracy, with the major challenge of achieving economic and social development and eradicating poverty, will engage in negotiations and other actions at the international level in the coming months that would lead to efficient and equitable solutions at the global level.

20.9. THE GEF

- Article 11 of the UNFCCC creates a 'financial mechanism' for convention implementation, which is to function under the guidance of the UNFCCC COP and be accountable to the COP.
- Under Article 11(1), the COP is to decide on the financial mechanism's policies, programme priorities and eligibility criteria relating to the convention.
- Article 21 names the GEF to serve as the financial mechanism on an interim basis.
- The GEF was established in 1991 by the World Bank in consultation with the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP), to provide funding to protect the global environment.
- The GEF's governance, operational, financial and administrative oversight procedures are set out in the Instrument for the Establishment of the Restructured Global Environment Facility, which was adopted in 1994 and subsequently amended in 2002 (GEF Instrument).
- The GEF now has six focal areas:
  1. biological diversity;
  2. climate change;
  3. international waters;
  4. land degradation, primarily desertification and deforestation;
  5. ozone layer depletion; and
  6. persistent organic pollutants.

20.10. CLIMATE-SMART AGRICULTURE

- While agriculture is the sector most vulnerable to climate change, it is also a major cause, directly accounting for about 14 percent of greenhouse gas emissions (IPCC 2007).
- And yet, agriculture can be a part of the solution: helping people to feed themselves and adapt to changing conditions while mitigating climate change.
- It is possible for agriculture to actually sequester or absorb carbon into the soil rather than emitting it. This can be done without the trade off with productivity and yields.
- It is possible to have higher yields, more carbon in the soil and greater resilience to droughts and heat.
- This is called the 'triple win': interventions that would increase yields (poverty reduction and food security), make yields more resilient in the face of extremes (adaptation), and make the farm a solution to the climate change problem rather than part of the problem (mitigation).
- These triple wins are likely to require a package of interventions and be country- and locality specific in their application. This method of practicing agriculture is called 'Climate Smart Agriculture'.

20.10.1 Climate-smart agriculture includes proven practical techniques.

For example,

- by increasing the organic content of the soil through conservation tillage, its water holding capacity increases, making yields more resilient and reducing erosion.
- Promoting soil carbon capture also helps mitigate climate change. Another example is integrated soil fertility management that can lower fertilizer costs, increase soil carbon and improve yields.
- Climate-smart agriculture gives attention to landscape approaches, for example, integrated planning of land, agriculture, forests, fisheries and water to ensure synergies are captured.
- These can be further strengthened by adding better weather forecasting, more resilient food crops and risk insurance to cover losses when the vagaries of weather strike.
- If yields increase through such practices and become more stable, it results in improved farm incomes. A more stable income helps enhance the adaptive capacity of farmers.
- A good number of countries are now showing that it can be done.
- China has been a leader in this, with programs such as the Loess Plateau now internationally famous.
- Brazil has also invested in good quality research and extension and is demonstrating these triple results.
- And small-holder farmers in Kenya are already receiving cash payments on a pilot basis for new farming techniques that will hold more carbon in the soil, even while increasing soil fertility.

Cop 17

- COP 17 in Durban offers a unique opportunity for Africa to shape the global climate agenda and establish an agriculture work program that is informed by science and covers adaptation and mitigation.

20.11.INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

- The UN General Assembly adopted a resolution, in December 1988, on the subject and endorsed the UNEP/WMO proposal for the setting up of the Inter-Governmental Panel on Climate Change (IPCC).
- It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the governments of the world with a clear scientific view of what is happening to the world's climate.
- The Secretariat coordinates all the IPCC work and liaises with Governments. The secretariat is supported by WMO and UNEP and hosted at WMO headquarters in Geneva.
- It is open to all member countries of the United Nations (UN) and WMO. Currently 195 countries are members of the IPCC.
- The initial task for the IPCC as outlined in the UN General Assembly Resolution 1988 was to prepare a comprehensive review and recommendations with respect to the state of knowledge of the science of climate change; social and economic impact of climate change, and possible response strategies and elements for inclusion in a possible future international convention on climate.
- IPCC's Role as defined in Principles Governing IPCC Work, "to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation".
- The IPCC is a scientific body. It reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change.
- It does not conduct any research nor does it monitor climate related data or parameters.
- Thousands of scientists from all over the world contribute to the work of the IPCC on a voluntary basis.
- Review is an essential part of the IPCC process, to ensure an objective and complete assessment of current information.
- Governments participate in the review process and the plenary Sessions, where main decisions about the IPCC work programme are taken and reports are accepted, adopted and approved.
- By endorsing the IPCC reports, governments acknowledge the authority of their scientific content. The work of the organization is therefore policy-relevant and yet policy-neutral, never policy-prescriptive.
- The IPCC has delivered on a regular basis the most comprehensive scientific reports about climate change produced worldwide, the Assessment Reports.
- It has also responded to the need of the UNFCCC for information on scientific and technical matters through Special Reports, Technical Papers and Methodology Reports.
- It has also produced methodologies and guidelines to help Parties to the UNFCCC prepare their national greenhouse gas inventories.

20.11.1.Assessment Reports

- In accordance with its mandate and as reaffirmed in various decisions by the Panel, the IPCC prepares at regular intervals comprehensive Assessment Reports of scientific, technical and socio-economic information relevant for the understanding of human induced climate change, potential impacts of climate change and options for mitigation and adaptation.
- Assessment Reports are normally published in several volumes, one for each of the Working Groups of the IPCC and, subject to the decision by the Panel, a Synthesis Report.
- Each of the Working Group volumes is composed of individual chapters, an optional Technical Summary and a Summary for Policymakers.
- Synthesis Reports synthesize materials contained within the Assessment Reports, eventually integrating them with information coming from the Special Reports as well.

- They are written in a non-technical style suitable for policymakers. They are composed of a longer report and a Summary for Policymakers.
- Four Assessment Reports have been completed in 1990, 1995, 2001 and 2007. The IPCC Fifth Assessment Report (AR5) is scheduled for completion in 2013/14.

IPCC 4th AR

- Warming of the climate system is unequivocal.
- Anthropogenic warming and sea level rise would continue for centuries due to the timescales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilized, although the likely amount of temperature and sea level rise varies greatly depending on the fossil intensity of human activity during the next century
- The probability that this is caused by natural climatic processes alone is less than 5%.
- World temperatures could rise by between 1.1 and 6.4 °C (2.0 and 11.5 °F) during the 21st century (table and that: Sea levels will probably rise by 18 to 59 centimetres
- There is a confidence level >90% that there will be more frequent warm spells, heat waves, and heavy rainfall.
- There is a confidence level >66% that there will be an increase in droughts, tropical cyclones, and extreme high tides.
- Both past and future anthropogenic carbon dioxide emissions will continue to contribute to warming and sea level rise for more than a millennium.
- Global atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values over the past 650,000 years.

AR5 Contents

- Compared with previous reports, the AR5 will put greater emphasis on assessing the socio-economic aspects of climate change and implications for sustainable development, risk management and the framing of a response through both adaptation and mitigation.
- The AR5 will comprise the full reports prepared by the Working Groups (I, II and III) as well as the Synthesis Report.
- Key AR5 cross-cutting themes will be:
  - Water and the Earth System: Changes, Impacts and Responses;
  - Carbon Cycle including Ocean Acidification;
  - Ice Sheets and Sea-Level Rise;
  - Mitigation, Adaptation and Sustainable Development; and
  - Article 2 of the UNFCCC (see UNFCCC for definition).

Special Reports

- Special Reports have been prepared on topics such as aviation, regional impacts of climate change, technology transfer, emissions scenarios, land use, land use change and forestry, carbon dioxide capture and storage and on the relationship between safeguarding the ozone layer and the global climate system.

20.12. NATIONAL GREEN HOUSE GAS INVENTORIES PROGRAMME (NGGIP)

- The IPCC established the national green house gas Inventories Programme (NGGIP) TO provide methods for estimating national inventories of greenhouse gas emissions to, and removals from, the atmosphere.
- The guidance produced by the NGGIP is used by countries that are Parties to the UN Framework Convention on Climate Change (UNFCCC) to estimate the emissions and removals that they report to the UNFCCC.
- It may be used by others who want to produce estimates consistent with national totals. Internationally agreed guidance is needed so that emission and removal estimates can be compared between countries and over time.
- All the IPCC guidance has therefore been compiled by an international range of authors and with an extensive global review process.

Methodology

- The first methodologies were produced by the IPCC in early 1990s and have been revised since (Development of IPCC Guidelines and Good Practice Guidance).
- The Revised 1996 Guidelines for National Greenhouse Gas Inventories, the Good Practice

Guidance and Uncertainty Management in National Greenhouse Gas Inventories (GPG2000) and the Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF) are used by developed countries to estimate emissions and removals, and are recommended by the UNFCCC for use by all countries.

- ➢ The 2006 IPCC Guidelines for National Greenhouse Gas Inventories (the 2006 Guidelines) are the IPCC's most recent guidance on methods and data for developing estimates of emissions and removals of greenhouse gases.
- ➢ They build on earlier guidance, over a decade of experience and a world-wide scientific and technical effort to produce guidelines, applicable to all countries notwithstanding widely varying levels of resources and expertise.

Mandate

- ➢ The current mandate of the National Greenhouse Gas Inventories Programme (NGGIP) was approved by IPCC16 (Montreal, May 2000). IPCC19 (Geneva, April 2002) decided to maintain its Task Force on Inventories, co-chaired by two members of the IPCC Bureau (one from an industrialized country and one from a developing country) with twelve additional members on the Task Force Bureau (two per IPCC/WMO region).
- ➢ The NGGIP is mandated to carry out the work, as approved by the Panel, on inventory-related methodologies and practices.

The Panel decided:

- ➢ That the IPCC is responsible for assessing and developing inventory methods and practices which are scientifically sound and relevant to all countries, noting particularly the lack of information in developing countries.
- ➢ This includes
  - (a) developing methods for estimating emissions of greenhouse gases (GHGs) by sources and removals by sinks,
  - (b) assessing and developing methods to quantify and to manage uncertainties in the estimates of GHGs,
  - (c) assessing the scientific literature related to the development of GHG emission factors and management of inventories,
  - (d) disseminating information related to inventory methods and practices,
  - (e) identifying the implications of the different options in relation to inventory methods and practices and
  - (f) assessing scientific issues related to independent verification.

20.13. GREEN ECONOMY

- ➢ The 'Green Economy' can be considered synonymous to a 'sustainable' economy. However, the Green Economy concept often carries a more distinctive meaning.
- ➢ Green economy focuses specifically on the fundamental changes that are required to ensure that economic systems are made more sustainable.Green Economy focuses on the ways to overcome the deeply rooted causes of unsustainable economic development.
- ➢ A Green Economy is one whose growth in income and employment is driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystems.
- ➢ The Green Economy is about sustainable energy, green jobs, low carbon economies, green policies, green buildings, agriculture, fisheries, forestry, industry, energy efficiency, sustainable tourism, sustainable transport, waste management, water efficiency and all other resource efficiency.

Transition to green economy

Three priorities in transition of economy to green economy are

- decarbonizes the economy;
- commit the environmental community to justice and equity; and
- conserve the biosphere.

A key step forward consists in changing our conception of growth and prosperity – achieving more with less and creating real wealth and quality of life.

Measures to adapt green economy

- ➢ Energy audit can reduce your building's climate footprint and lead to significant savings in energy costs.

- Overfishing in many parts of the world threatens to deplete future fish stocks. We can avoid this by working to promote sustainable fishing practices.
- Deforestation accounts for close to 20% of the world's greenhouse gas emissions.
- Sustainably managed forests can continue to support communities and ecosystems without damaging environment and climate.
- Use electronic files to reduce your demand for paper products.
- When you support certified sustainable forest products, you support a healthy environment and sustainable livelihoods.
- Car-pooling or taking public transport reduces environmental impacts and economic costs while strengthening community.
- Walking or riding a bike for short trips is good for your health - and the environment.
- Taking small steps towards wise water use can help conserve this precious resource.
- Resource efficiency is key to a Green Economy and water is one of our most important resources.
- The development of clean, renewable energy by using solar, wind, tidal,etc will contribute to green economy.
- Recycling appropriate materials and composting food waste reduces the demand on our natural resources.
- Moving towards a green economy has the potential to achieve sustainable development and eradicate poverty on an unprecedented scale, with speed and effectiveness.

◆◆◆◆◆◆

PART - IV

CHAPTER - 21

AGRICULTURE

"A man without food
For three days will quarrel,
For a week will fight and
For a month or so will die"

AGRICULTURE

- The term agriculture is derived from two Latin words ager or agri meaning soil and cultura meaning cultivation. Agriculture is a broad term encompassing all aspects of crop production, livestock farming, fisheries, forestry etc.
- Agriculture is defined as an art, science and business of producing crops and livestock for economic purposes
- The word AGRICULTURE thus may be expanded as Activities on the Ground for Raising Intended Crops for Uplifting Livelihood Through the Use Of Rechargeable Energies.
- SilviCulture is the art of cultivating forest trees.
- Sericulture is the rearing of silkworms for the production of raw silk.
- Apiculture is the maintenance of honey bee colonies, commonly in hives, by humans
- Olericulture is the science of vegetable growing, dealing with the culture of non-woody (herbaceous) plants for food.
- Viticulture is the science, production and study of grapes
- Floriculture is a discipline of horticulture concerned with the cultivation of flowering and ornamental plants for gardens
- Arboriculture is the cultivation, management, and study of individual trees, shrubs, vines, and other perennial woody plants
- Pomology is a branch of horticulture which focuses on the cultivation, production, harvest, and storage of fruit, etc.
- Aeroponics is the process of growing plants in an air or mist environment without the use of soil or an aggregate medium
- Hydroponics is a method of growing plants using mineral nutrient solutions, in water, without soil.
- Terrestrial plants may also be grown with their roots in the mineral nutrient solution only or in an inert medium, such as perlite, gravel, mineral wool, expanded clay or coconut husk.
- Geoponic in farming practice, refers to growing plants in normal soil

Scope and Importance of Agriculture

- With a 17.2 per cent contribution to the gross domestic product (GDP), agriculture provides livelihood support to about two-thirds of country's population.
- The sector provides employment to 56.7 per cent of country's work force and is the single largest private sector occupation.
- Agriculture accounts for about 14.7 per cent of the total export earnings and provides raw material to a large number of Industries (textiles, silk, sugar, rice, flour mills, milk products).
- The agriculture sector acts as a bulwark in maintaining food security and, in the process, national security as well.
- The allied sectors like horticulture, animal husbandry, dairy and fisheries, have an important role in improving the overall economic conditions and health and nutrition of the rural masses.

Problems of Indian Agriculture

- Fragmentation of land holding.
- Existence of small and marginal farmers.
- Regional variation.
- Dependence of seasonal rainfall.
- Low productivity of land.

- Increasing of disguised unemployment.
- Disorder in marketing of Agricultural products.
- Weak land reformation.

Revolutions in Agriculture

Revolution	Related with
Green	Food grain Production
Golden	Fruit Production
Grey	Fertilizer Production
Blue	Fish Production
Black	Petroleum Production
Pink	Prawn Production
Round	Potato Production
Red	Meat/Tomato Production
Silver	Egg/Poultry Production
White	Milk Production
Yellow	Oil seeds Production

Land utilization statistics

In India

1. Total geographical area	:	328.848 million ha.
2. Total reporting area	:	304.300 million ha.
3. Area under cultivation	:	143.000 million ha.
4. Total cropped area	:	179.750 million ha.
5. Area sown more than once	:	36.750 million ha.
6. Area not available for cultivation	:	161.300 million ha.
7. Area under forest	:	66.400 million ha.

CROP AND ITS CLASSIFICATIONS

- Agronomy is a Greek word derived from agros meaning field and nomos meaning management. It is a specialized branch in agriculture dealing with crop production and soil management. Crops refer to plants that are grown on a large scale for food, clothing, and other human uses.

Classification based on climate

1. Tropical: Crops grow well in warm & hot climate. E.g. Rice, sugarcane, Jowar etc
2. Temperate: Crops grow well in cool climate. E.g. Wheat, Oats, Gram, Potato etc.

Classification Based on growing season

1. Kharif/Rainy/Monsoon crops: The crops grown in monsoon months from June to Oct-Nov, Require warm, wet weather at major period of crop growth, also required short day length for flowering. E.g. Cotton, Rice, Jowar, bajara.
2. Rabi/winter/cold seasons crops: The crops grown in winter season from Oct to March month. Crops grow well in cold and dry weather. Require longer day length for flowering. E.g. Wheat, gram, sunflower etc.
3. Summer/Zaid crops: crops grown in summer month from March to June. Require warm dry weather for major growth period and longer day length for flowering. E.g. Groundnuts, Watermelon, Pumpkins, Gourds.

Agronomic Classification of Crops

Cereals

- Cereals are cultivated grasses grown for their edible starchy grains. Larger grains used as staple food are cereals. Rice, wheat, maize, barley and oats. The important cereal of world is rice.

No.	Crop		Scientific name
1.	Rice	-	Oryza sativa
2.	Wheat		
	Bread wheat	-	Triticum aesticum, Triticum valgare
	Macaroni wheat	-	T. durum
	Emmer wheat	-	T. dicoccum (Mysore & Nilgiri)
	Dwarf wheat	-	T. sphaerococcum
3.	Maize or corn	-	Zea mays
4.	Barley	-	Hordeum vulgare
5.	Rye	-	Secale cereale
6.	Oats	-	Avena sativa

Millets

- They are also annual grasses of the group cereals. But they are grown in less area or less important area whose productivity and economics are also less important.
- These are staple food of poor people. In India pearl millet is a staple food in Rajasthan
- 1) Major millets and 2) Minor millets
- It is based on area production and productivity and grain size.

Major millets

No.	Millet		Scientific name
1.	Sorghum /Jowar/Cholam	-	Sorghum bicolor
2.	Pearl Millet /Bajra/cumbu	-	Pennisetum typhoides
3.	Finger millet or ragi	-	Eleusine coracona

Minor millets

1. Fox tail millet / Thenai - Setaria italica
2. Little millet / Samai - Panicum miliare
3. Common millet / Panivaraugu - Panicum miliaceum
4. Barnyard millet / Kudiraivali - Echinchloacolona var frumentaceae
5. Kodomillet / Varagu - Paspalum scrobiculatum

Pulses or Grain Legumes

- Pulses are major source of protein in Indian vegetarian diet. These are main source of protein providing most of the essential amino acids to a certain degree. Economically, pulses are cheapest source of protein.
- It is cultivated to enrich the soil, to utilize the residual moisture and to give revenue in a shorter period.

1. Red gram - Cajanus cajan
2. Black gram - Vigna mungo
3. Green gram - V. radiata
4. Cowpea - V. unguiculata
5. Bengalgram - Cicer arietinum
6. Horsegram - Macrotyloma uniflorus
7. Dewgram - Phaseolus aconitifolius
8. Soyabean - Glycine max
9. Peas or gardenpea - Pisum sativum
10. Garden bean - Lablab purpureus

Oil Seed Crops

- These crops are cultivated for the production of oil. Either for edible on industrial or medicinal purpose. They contain more of fat.

1. Groundnut or peanut - Arachis hypogeae
2. Sesamum or gingelly - Sesamum indicum
3. Sunflower - Helianthus annuus
4. Castor - Ricinus communis
5. Linseed or flax - Linumusitatissimum
6. Niger - Guizotia abyesinia
7. Safflower - Carthamus tinctorius
8. Rapeseed & Mustard - Brassica sp.
   - 45 – 50% oil content is present in these seeds.

Sugar Crops

- Juice extracted from stem used for jaggery or sugar
- Number of by products like Molasses, bagasse,pressmud
- Molasses used for alcohol and yeast formation
- Bagasse for paper making and fuel
- Pressmud used for soil amendment
- Trash (green leaf + dry foliage) – the waste is used for cattle feed
- Sugar beet – Tuber for extraction of sugar
- Tubers and tops are used as a fodder for cattle feed

1. Sugarcane - Saccharum officinarum
2. Sugar beet - Beta vulgaris var saccharata

Starch Crops or Tuber Crops

1. Potato - Solanum tuberosum
2. Tapioca or cassava - Manihot esculenta
3. Sweet potato - Ipomea batatus

Fibre Crops

- Epidermal hairs of seed coats is the economic portion
- Lint (cappas – seed) has industrial value (fibre)
- Stalk is of fuel nature, garment purpose, Seed for cattle feed,Oil is edible

Cotton

- Gassypium arboreum (Karunganni)
- G. herbaceum (uppam cotton)
- G. hirsutum (American cotton or Cambodium cotton)
- G. barbadense (Egyptian cotton or Sea island cotton)

Stem Fibres

a) Jute (channal) - Corchorus capsularis
b) Mesta (pulicha keerai) - Hibiscus cannabinus
c) Sun hemp - Crotolaria juncea
d) Sisal hemp - Agave sisalana

Narcotics

- Stimulates Nervous System

i) Tobacco - Nicotiana tabaccum
ii) Betelvine - Piper betle
iii) Arecanut - Areca catechu

Forage and Fodder Crops

Forage Crops

- ➢ The entire vegetative part is used as green fodder
- ➢ the stalks and leaves are the major economic portion for hay making
- ➢ Hay is cut into pieces and mixed with concentrated animal feed and is fed to animals

Grasses

- Napier grass - Pennisetum typhoides
- Para grass - Brachiaria mutica
- Bermuda grass (Hariyali) - Cynodon dactylon
- Guinea grass - Panicum maxium
- Rhodes grass - Chloris gayana

Legumes

1) Lucerne (Alfalfa) – Medicago sativa
2) Egyptian clover (Bersemm) - Trifolium alexandrium
3) Indian clover (Fodder senji) - Melilous parviflora
4) Sirato - Macroptilium atropurpureum
5) Stylo - Stylsanthus hamata/ scabra
6) Subabul - Leuceana leucocephala
7) Velvet bean - Mucuna cochinchinensis

Plantation Crops

- ➢ 1) Tea – leaf; 2) Coffee – seed; 3) Rubber – milk exudation; 4) Cocoa - seed

Spices and Condiments

- ➢ Products of crop plants are used to flavor taste and sometime color the fresh preserved food. E.g. ginger, garlic, chili, cumin onion, coriander, cardamom, pepper, turmeric etc.
- ➢ Medicinal & aromatic crops: Medicinal plants includes cinchona, isabgoli, opium poppy, senna, belladonna, rauwolfra, iycorice and aromatic plants such as lemon grass, citronella grass, palmorsa, Japanese mint, peppermint, rose, jasmine, henna etc.

Classification based on life of crops/duration of crops:

1. Seasonal crops: A crop completes its life cycle in one season. E.g. rice, Jowar, wheat etc.
2. Two seasonal crops: crops complete its life cycle in two seasons. E.g. Cotton, turmeric, ginger.
3. Annual crops: Crops require one full year to complete its life cycle. E.g. sugarcane.
4. Biennial crops: Crops requires two year to complete its life cycle E.g. Banana, Papaya.
5. Perennial crops: crops live for several years. E.g. Fruit crops, mango, guava etc.

Classification based on cultural method/water:

1. Rain fed: Cultivation of crop mainly based on the availability of rain water. E.g. Jowar, Bajara, Mung etc.
2. Irrigated crops: Crops cultivated with the help of irrigation water. E.g. Chili, sugarcane, Banana, papaya etc.

Classification based on root system

1. Tap root system: The main root goes deep into the soil. E.g. Tur, Grape, Cotton etc.
2. Fiber rooted: The crops whose roots are fibrous shallow & spreading into the soil. E.g. Cereal crops, wheat, rice etc.

Classification based on economic importance

1. Cash crop: Grown for earning money. E.g. Sugarcane, cotton.
2. Food crops: Grown for raising food grain for the population and & fodder for cattle. E.g. Jowar, wheat, rice etc.

Classification based on No. of cotyledons

1. Monocots or monocotyledons: Having one cotyledon in the seed. E.g. all cereals & Millets.
2. Dicots or dicotyledonous: Crops having two cotyledons in the seed. E.g. all legumes & pulses and almost all the trees.

Classification based on length of photoperiod required for floral initiation

- ➢ Most plants are influenced by relative length of the day & night, especially for floral initiation, the effect on plant is known as photoperiodism depending on the length of photoperiod required for floral ignition, plants are classified as:

1. Short-day plants: Flower initiation takes place when days are short less then ten hours. E.g. rice, Jowar, green gram, black gram etc.
2. Long day's plants: require long days are more than ten hours for floral initiation. E.g. Wheat, Barley, etc.
3. Day neutral plants: Photoperiod does not have much influence for phase change for these plants. E.g. Cotton, sunflower, etc.

TILLAGE

- Tillage is the mechanical manipulation of soil with tools and implements for obtaining conditions ideal for seed germination, seedling establishment and growth of crops.
- **Tilth:** It is the physical l condition of soil obtained out of tillage (or) it is the result of tillage. The tilth may be a coarse tilth, fine tilth or moderate tilth. Based on the requirement of crops being grown and the soil where we are cultivating.
- **Types of tillage:** Tillage operations may be grouped into

  1. On season tillage 2. Off-season tillage
- **On-season tillage:** Tillage operations that are done for raising crops in the same season or at the onset of the crop season are known as on season tillage.
- **Preparatory tillage:** This refers to tillage operations that are done to prepare the field for raising crops. It consists of deep opening and loosening of the soil to bring about a desirable tilth as well as to incorporate or uproot weeds and crop stubble when the soil is in a workable condition.

Types of preparatory tillage

1. Primary tillage
2. Secondary tillage

- **Primary tillage:** The tillage operation that is done after the harvest of crop to bring the land under cultivation is known as primary tillage. Ploughing is the opening of compact soil with the help of different ploughs. Country plough, mould board plough, bose plough, tractor and power tiller are used for primary tillage.
- **Secondary tillage:** The tillage operations that are performed on the soil after primary tillage to bring a good soil tilth are known as secondary tillage. Secondary tillage consists of lighter or finer operation which is done to clean the soil, break the clods and incorporate the manure and fertilizers. Harrowing and planking is done to serve those purposes
- **Dry tillage:** Dry tillage is practiced for crops that are sown or planted in dry land condition having sufficient moisture for germination of seeds. This is suitable for crops like broadcasted paddy, jute, wheat, oilseed crops, pulses, potato and vegetable crops.
- **Wet or puddling tillage:** The tillage operation that is done in a land with standing water is called wet or puddling tillage. Puddling operation consists of ploughing repeatedly in standing water until the soil becomes soft and muddy. Puddling creates an impervious layer below the surface to reduce deep percolation losses of water and to provide soft seed bed for planting rice.
- **Off-season tillage:** Tillage operations done for conditioning the soil suitably for the forthcoming main season crop are called off-season tillage. Off season tillage may be

  1. Post harvest tillage
  2. Summer tillage
  3. Winter tillage
  4. Fallow tillage
- **Special purpose tillage:** Tillage operations intended to serve special purposes are said to be special purpose tillage. They are, 1) sub soiling, 2) levelling, 3) clean tillage, 4) blind tillage, 5) wet tillage and 6) zero tillage.
- **Sub soiling:** To break the hard pan beneath the plough layer special tillage operations (chiselling) are performed to reduce compaction. Sub soiling is essential once in four to five years where heavy machineries are used for field operations, seeding, harvesting, transporting etc.

Advantages

- greater volume of soil may be obtained for cultivation of crops
- excess water may percolate downward to recharge the permanent water table
- reduce runoff and soil erosion
- roots of crop plants can penetrate deeper to extract moisture from the water table
- **Clean tillage:** It refers to working of the soil of the entire field in such a way no living plant is left undisturbed. It is practiced to control weeds, soil borne pathogen and pests.

- **Blind tillage:** It refers to tillage done after seeding or planting the crop (in a sterile soil) either at the pre – emergence stage of the crop plants or while they are in the early stages of growth so that crop plants (cereals, tuber crops etc.) do not get damaged, but extra plants and broad leaved weeds are uprooted.
- **Zero tillage (No tillage):** In this, new crop is planted in the residues of the previous crop without any prior soil tillage or seed bed preparation and it is possible when all the weeds are controlled by the use of herbicides.

Advantages of Zero tillage

1. Zero tilled soils are homogenous in structure with more number of earthworms
2. Organic matter content increases due to less mineralization
3. Surface runoff is reduced due to presence of mulch

Disadvantages

1. Higher amount of nitrogen has to be applied for mineralization of organic matter in zero tillage
2. Perennial weeds may be a problem
3. High number of volunteer plants and buildup of pests

CROPPING

- **Cropping intensity:** Number of crops cultivated in a piece of land per annum is cropping intensity. In Punjab and Tamil Nadu the cropping intensity is more than 100 per cent i.e. around 140-150%. In Rajasthan the cropping intensity is less.

Cropping pattern

- The yearly sequence and spatial arrangement of crops and fallow on a given area is called cropping pattern

Cropping system

- The cropping pattern used on a farm and its interactions with farm resources, other farm enterprises, and available technology which determine their makeup.
- **Multiple cropping:** Growing more than two crops in a piece of land in a year in orderly succession. It is also called as intensive cropping. It is used to intensify the production. It is possible only when assured resources are available (land, labour, capital and water)
- **Double cropping:** Growing two crops a year in sequence. Example: Rice - Pulse
- **Triple cropping:** Growing three crops a year in sequence. Example: Rice - Rice - Pulse
- **Quadruple cropping:** Growing four crops in a year in sequence
- **Monoculture:** Repetitive growing of the same sole crop in the same land.
- **Mono cropping:** Continuous production of one and the same crop year after year or season after season is called mono cropping.
- **Sole cropping:** One crop variety grown alone in a pure stand at normal density.

Sequential cropping

- Growing of two or more crops in sequence on the same field in a year. The succeeding crop is planted after the preceeding crop has been harvested
  - The crop intensification is done in time dimension
  - Ex: Rice-rice-cotton
- Relay cropping Growing the succeeding crop when previous crop attend its maturity stage-or-sowing of the next crop immediately before the harvest of the standing crops.

E.g. 1) Paddy-Lucerne.

2) Rice-Cauliflower-Onion-summer gourds.

Ratoon cropping

- Raising a crop with regrowth coming out of roots or stocks of the harvested crop
  - Ex: Sugarcane (8 ratoons in Cuba)
  - Banana – one plant crop followed by two ratoon crops normally
  - Sorghum and Lucerne fodder- many ratoons Ist cutting 70 DAS and thereafter every 35-40 days.
  - Pineapple crop is extensively ratooned.

Intercropping

- Growing two or more crops simultaneously with distinct row arrangement on the same field at the same time.
  - **Base crop:** primary crop which is planted/ sown at its optimum sole crop population in an intercropping situation.
  - **Intercrop :** This is a second crop planted in between rows of base crop with a view to obtain extra yields with intercrop without compromise in the main crop yields

Advantages of Intercropping

- ➢ Better use of growth resources including light, nutrients and water
- ➢ Suppression of weeds
- ➢ Yield & stability - even if one crop fails due to unforeseen situations, another crop will yield and provides some secured income
- ➢ Successful intercropping gives higher equivalent yields (yield of base crop + yield of intercrop), higher cropping intensity
- ➢ Reduced pest and disease incidences
- ➢ Improvement of soil health and agro-eco system

Examples of Inter cropping

➢ Ex: Maize + Cowpea	1:1
➢ Sorghum + Redgram	2:2
➢ Groundnut + Redgram	6:1
➢ Potato + Mustard	3:1
➢ Wheat + Mustard	8:1

Types of intercropping

- ➢ Strip intercropping
- ➢ Parellel cropping
- ➢ Synergistic cropping
  - Additive Series (Paired row intercropping)
  - Replacement Series
- ➢ Multi storey cropping
- ➢ Relay intercropping
- ➢ Alley cropping

Strip intercropping

- ➢ Growing of two or more crops simultaneously in strips wide enough to permit independent cultivation but narrow enough for the crops to interact each other.
- ➢ Ex:6 rows of groundnut and 4 rows of redgram in strips

Parellel cropping

- ➢ Growing of two crops simultaneously which have different growth habits and no competion among themselves
- ➢ Ex: Blackgram with maize
- ➢ Soybean with cotton

Synergestic Cropping

- ➢ Yields of both crops are higher than of their pure crops on unit area basis
- ➢ Ex: Sugarcane + Potato

Multi storey cropping

- ➢ Cultivation of more than two crops of different heights simultaneously on a piece of land in any certain period
  - Ex: Coconut + Pepper + cocoa + pineapple

Relay intercropping

- ➢ In a long duration base crop, growing two sets of intercrops one after another is called relay intercropping
  - Ex; Redgram – base crop 180 days
  - Groundnut/onion/coriander-I set of intercrops
  - Samai/ thenai/panivaragu- 2nd set of intercrops

Alley cropping

- ➢ Alley cropping is a system in which food crops are grown in alleys formed by hedge rows of trees or shrubs. The essential feature of the system is that hedge rows are cut back at planting and kept pruned during cropping to prevent shading and to reduce competition with food crops.
  - Ex: Subabul raised at 6 m row spacing
  - The space between two rows called alleys
  - The intercrops are raised in the alley space
  - E.g. cotton, sorghum, blackgram

Mixed cropping

- ➢ Growing of two or more crops simultaneously intermingled without row arrangement is known as mixed cropping
- ➢ It is a common practice in most of dryland tracts in India
- ➢ Seeds of different crops are mixed in certain proportion and are sown
- ➢ The objective is to meet the family requirement of cereals, pulses and vegetables, it is a subsistence farming
- ➢ Ex: Sorghum, Bajra and cowpea are mixed and broadcasted in rainfed conditions (with low rainfall situations) to avoid complete crop failures and with ascertaining the minimum yields

Difference between inter cropping and mixed cropping

Inter cropping	Mixed cropping
The main objective of inter cropping is to utilise the space between rows of main crop and to produce more grain per unit area	The main objective of mixed cropping is insurance against crop failure.
There is no competition between main and inter crop (subsidiary crop)	There is competition between component crops. Here all crops are given equal importance and care. Hence, there is no difference between component crops
In inter cropping, the main crop may be a long duration one and the inter crop may be a short duration/early maturing one	Crops may or may not be of same duration
Main and inter crops are sown in definite row arrangement	There is no specific row arrangement. Generally crop seeds are mixed and broadcasted
The sowing time of both the crops may or may not be the same. Sometimes the main crops is sown earlier than the inter crop	The sowing time of component crops is same.

FARMING SYSTEMS

Definitions

- Farm – is a piece of land with specific boundaries, where crop and livestock enterprises are taken up under common management
- Farming – is the process of harnessing solar energy in the form of economic plant and animal products
- System – a set of components which are interdependent and interacting

Wetland farming

- Wet land – soils flooded or irrigated through lake, pond or canal and land is always in submerged condition
- Wetland farming: is the practice of growing crops in soils flooded through natural flow of water for most part of the year

Garden land/ irrigated Dry land farming

- Garden land – soils irrigated with ground water sources
- Garden land farming: Growing crops with supplemental irrigation by lifting water from underground sources.

Dry land farming

- Dry land – soils purely depends rainfall for moisture
- Dryland farming: is the practice of crop production entirely depending upon rainfall and the moisture conserved in the soil
- This is practiced in areas where annual rainfall is less than 750mm.The crops may face moisture stress frequently due to erratic distribution or failure of monsoon

Rain fed farming

- Crop production in areas where rainfall is more than 750mm (i.e assured rainfall areas). Here moisture stress will be minimum. Soil conservation is given more importance

Mixed Farming

- Mixed farming is defined as a system of farming on a particular farm which includes crop production, raising live stock, poultry, fisheries, bee keeping etc. to sustain and satisfy as many needs of the farmer as possible. Subsistence is important objective of mixed farming. While higher profitability without altering ecological balance is important in farming system.

Advantages:

1. It offers highest return on farm business, as the byproducts of farm are properly utilized.
2. It provides work throughout year.
3. Efficient utilization of land, labour, equipment and other resources.
4. The crop by-products such as straw, fodder etc. is used for feeding of livestock and in return they provide milk.
5. Manures available from livestock to maintain soil fertility.
6. It helps in supplying all the food needs of the family members.

Specialized Farming

- The farm in which 50% or more income of total crop production is derived from a single crop is called specialized farming

Diversified Farming

- A diversified farming has several production enterprises or sources of income but no source of income equal as much as 50% of the total income. It is also called as general farming.

CROP ROTATION

- Growing of different crops on a piece of land is a preplanned succession. The principle of crop rotation is to utilise the available resources to the fullest extent in order to harvest the maximum in a unit land without affecting the soil health.
- Ex- Rice-Red Gram -Banana

Principles of crop rotation

- Leguminous crops should be grown before non-leguminous crops because legumes fix atmospheric N into the soil and add organic matter to the soil.
- Crops with tap roots (deep rooted like cotton) should be followed by those which have fibrous (shallow rooted crops like sorghum or maize) root system. This facilitates proper and uniform use of nutrients from the soil.
- More exhaustive crops should be followed by less exhaustive crops because crops like potato, sugarcane, maize etc. need more inputs such as better tillage, more fertilizers, greater number of irrigation etc.
- Selection of crop should be based on need or demand
- Crops of same family should not be grown in succession because they act as alternate hosts for insect pests and diseases
- The selection of crops should suit farmers financial conditions
- The crop selected should also suit to the soil and climatic condition

SUSTAINABLE AGRICULTURE

- It is a form of agriculture aimed at meeting the needs of the present generation without endangering the resource base of the future generations. It is considered as a system of cultivation with the use of manure, crop rotation and minimal tillage and with minimum dependence on synthetic fertilizers, pesticides and antibiotics. It is a balanced management system of renewable resources including soil, wildlife, forests, crops, fish, livestock, plant genetic resources and ecosystems without degradation and to provide food, livelihood for current and future generations maintaining or improving productivity and ecosystem services of these resources.
- Sustainable agriculture has to prevent land degradation and soil erosion. It has to replenish nutrients and control weeds, pests and diseases through biological and cultural methods.
- Degradation of natural resources is the main issue threatening sustainable development of agriculture.

ORGANIC FARMING

- Organic farming is a production system where all kinds of agricultural products are produced organically, including grains, meat, dairy, eggs, fibers such as cotton, flowers, and processed food products
- Organic farming avoids or largely excludes the use of synthetic fertilizers, pesticides, growth regulators and livestock feed additives.

Components of organic farming

- It largely rely upon crop rotations, crop residues, animal manure, legumes, green manure, on/off farm organic wastes, mechanical cultivation, mineral bearing rocks and aspects of biological control of pests and diseases to maintain soil productivity and tilth to supply plant nutrients.

Scope

1. A sustainable agricultural system which maintains and improves soil fertility so as to guarantee for adequate food security in the future.
2. It relies upon resources from its own area which is not depended much on imported resources.
3. It helps in maintaining the stability of natural ecosystem

Concepts

1. Building up of biological soil fertility
2. Control of pests, diseases and weeds through development of an ecological balance within the system and by use of bioagents and various cultural techniques.
3. It recycles all wastes and manure within the farm.

- Eco-farming: Farming in relation to ecosystem.
- Biological farming: Farming in relation to biological diversity.
- Biodynamic farming: Farming which is biologically organic and ecologically sound and sustainable farming.

Organic farming –Components:

- The components of organic farming are
  - i) Organic manures
  - ii) Non- chemical weed control and
  - iii) Biological pest and disease management.

Principles:

- The three interrelated principles are
  - i) Mixed farming
  - ii) Crop rotation
  - iii) Organic cycle optimization

Eco-farming:

- It is the farming mutually reinforcing ecological approaches to food production. It aims at the maintenance of soil chemically, biologically and physically the way nature would do if left alone. Soil would then take proper care of plants growing on it. Feed the soil, not the plant is the watchword and slogan of ecological farming.

PERMACULTURE

- Bill Mollison, an Australian ecologist, and one of his students, David Holmgren, coined the word "permaculture" in 1978. It is a contraction of "permanent agriculture" or "permanent culture."
- It is defined as a design system for creating sustainable human environments. It uses ecology as the basis for designing integrated systems of food production, housing, appropriate technology, and community development.
- Permaculture is built upon an ethic of caring for the earth and interacting with the environment in mutually beneficial ways.
- A central theme in Permaculture is the design of ecological landscapes that produce food. Emphasis is placed on multi-use plants, cultural practices such as sheet mulching and trellising, and the integration of animals to recycle nutrients and graze weeds.

Characteristics

- It is one of the most holistic, integrated systems analysis and design methodologies found in the world.
- It can be applied to create productive ecosystems from the human- use standpoint or to help degraded ecosystems recover health and wildness.
- It can be applied in any ecosystem, no matter how degraded.
- It values and validates traditional knowledge and experience.
- Incorporates sustainable agriculture practices and land management techniques and strategies from around the world
- It is a bridge between traditional cultures and emergent earth-tuned cultures.
- It promotes organic agriculture, which does not use pesticides.
- It aims to maximize symbiotic and synergistic relationships between site components.
- It's design is site specific, client specific, and culture specific

INTEGRATED FARMING SYSTEM

- Integration of farm enterprises such as cropping systems, animal husbandry, fisheries, forestry etc. for optimal utilisation of resources bringing prosperity to the farmer. According to the availability of land, type of land, water, capital, resources, technical skill of the farmer, market facilities etc., and the components of farming system are to be chosen and adopted for better results.

Benefits of Integrated Farming System

- Steady income other than income from regular cropping
- Risk coverage due to subsidiary allocation in the event of unexpected crop failures
- Employment opportunity
- Higher productivity
- Augmented returns and recycling of organics
- Easily adopted by marginal and submarginal farmers
- General uplift of farm activities
- Better utilisation of land, labour, time and available manures in the farm.

ELEMENTS REQUIRED IN PLANT GROWTH

1. **Macronutrients:**

- Based on the relative abundance in plants, viz., Nitrogen (N); Phosphorous (P), Potassium (K), Sulfur (S), Calcium (Ca) and Magnesium (Mg)

2. **Micronutrients:**

- Their concentration is very small. They are also referred to as minor elements.
- Iron (Fe); Zinc (Zn); Manganese (Mg),Copper (Cu),Boron (B), Chlorine (Cl) and Molybdenum (Mo) .In some plants, other than the above, Sodium (Na), Cobalt (Co), Vanadium (Va), Nickel (Ni) and Silicon (Si) are considered as essential micronutrients

Nitrogen (N)

a] N is an essential constituent of proteins and is present in many other compounds of great physiological importance in plant metabolism

b] N is an integral part of chlorophyll, which is primary observer of light energy needed for photosynthesis.

c] N also imparts vigorous vegetative growth and dark green colour to plants.

- Phosphorus (P) is an essential part of the enzymes which help the crop to fix light energy. It forms an integral part of nucleic acids, the carriers of genetic information, and is important in stimulating root growth
- Potassium (K) is involved in processes which ensure carbon assimilation and the transportation of photosynthates throughout the plant for growth and the storage of sugars and proteins. The potassium ion is also important for water regulation and uptake. Furthermore, the presence of potassium in sufficient amounts ensures resistance to frost, drought and certain diseases
- Magnesium occurs in chlorophyll and is also an activator of enzymes,
- Sulphur forms part of two essential amino acids which are among the many building blocks of protein. It is also found in vitamin B1 and in several important enzymes.
- Calcium is required for plant growth, cell division and enlargement. The growth of root and shoot tips and storage organs is also affected by calcium as it is a component of cell membranes. Calcium is also vital for pollen growth and to prevent leaf fall

MANURES

- Manures are plant and animal wastes that are used as source of plant nutrients They release nutrients after their decomposition .Manures can be grouped into bulky organic manures and concentrated organic manures

Fertilizers

- Fertilizers are industrially manufactured chemical containing plant nutrients Nutrient content is higher in fertilizers than organic manures and nutrients are released almost immediately

Role of manures

1. Organic manures bind the sandy soil and improve its water holding capacity.
2. They open the clayey soil and help in aeration better root growth.
3. They add plant nutrients in small percentage and also add micro nutrients which are essential for plant growth the microbial activity is increased which helps in releasing plant nutrients in available for e.g. bulky organic manures-FYM, compost from organic waste, night soil, sludge, sewage, sheep folding, green manures, concentrated organic manures- oilcakes (edible, non-edible), blood meal, fish meal, bone meal.
4. Organic manures should be incorporated before the sowing or planting because of slow release of nutrients

Classification of Organic manures

Farm Yard Manure

- This is the traditional manure and is mostly readily available to the farmers. Farm yard manure is a decomposed mixture of Cattle dung and urine with straw and litter used as bedding material and residues from the fodder fed to the cattle..

Compost Manure

- Compost is well rotted organic manure prepared by decomposition of organic matter. Composting is largely a biological process in which micro-organisms of both types, aerobic (require oxygen for deep development) and anaerobic (functions in absence of air or free oxygen), decompose the organic matter and lower down the C:N ratio of refuse. The final product of composting is well rotted manure known as compost

Sheep and Goat droppings

- It is also valuable organic manure. It contains about 0.5 to 0.7 % N, 0.4 to 0.6% P2O5 and 0.3 –1.0% K2O. It is effective to all types of crops

Concentrated organic manures

Oil cakes

- There are many varieties of oil cakes which contains not only nitrogen but also some P and K along with large percentage of organic matter. These oil cakes are of two types.
    - i. Edible oil cakes- suitable for feeding cattle.
    - ii. Non-edible oil cakes-not suitable for feeding cattle.
- Oil cakes are quick acting organic manure. Though they are insoluble in water, their nitrogen became quickly available to plants in about a week or in 10 days after application.

Bone Meal

- Bones from slaughter houses, carcasses of all animals and from meat industry constitute bone meal, which is the oldest phosphatic fertilizer used. It also contains some N.

Fish meal

- Fish manure or meal is processed by drying non-edible fish, carcasses of fish and wastes from fish industry. It contains 4.0-10.0 % nitrogen, 3.0-9.0 % P and 0.3 to 1.5 % K. Fishmeal is quick acting organic manure and is suitable for application to all crops on all soils.

Green Manuring

- It is a practice of ploughing in the green plant grown in the field or adding green plants from outside and incorporating them into the soil for improving the physical structure as well as fertility of the soil. E.g.: Sannhemp, Dhaicha, Pillipesara, Shervi, Urd, Mung, Cowpea, Berseem, Senji, etc.

Green leaf Manuring

- Green leaf manuring refers to adding the green leaf and green twigs from legume plants or trees to a field and then incorporating them into the soil by ploughing. E.g.: Glyricidia, wild Dhaicha, Karanj (pongamia), leucaena.

Bio-fertilizers

- Bio-fertilizers are the preparations containing live or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulolyotic micro-organisms used for application to seed or composting areas with the objective of increasing the numbers of such micro-organisms and accelerating those microbial processes which augment the availability of nutrients that can be easily assimilated by plants. Bio-fertilizers harness atmospheric nitrogen with the help of specialized micro-organisms which may be free living in soil or symbiotic with plants.

Nitrogen fixers

1. Symbiotic: - Rhizobium, inoculants for legumes.
2. Non-symbiotic: - For cereals, millets and vegetables.

a) Bacteria:-
    - i) Aerobic:-Azatobacter, Azomonas, Azospirillum.
    - ii) Anaerobic:- Closteridium, chlorobium
    - iii) Facultative anaerobes- Bacillus, Eisherichia

b) Blue green algae- Anabaena, Anabaenopsis, Nostoe
    - A. Phosphate solubilizing micro-organisms.
    - B. Cellulolytic and lignolytic micro organisms.
    - C. Sulphur dissolving bacteria.
    - D. Azolla.

Integrated Nutrient Management (INM)

- Judicious combination of organic, inorganic and biofertilizers which replenishes the soil nutrients which are removed by the crops is referred as Integrated Nutrient Management system
- To sustain the productivity of different crops and cropping systems, efficient nutrient management is vital. There is a need to develop more efficient, economic and integrated system of nutrient management for realizing high crop productivity without diminishing soil fertility

WEEDS

- Weeds are unwanted and undesirable plant that interfere with utilization of land and water resources and thus adversely affect crop production and human welfare
- They are gregarious in nature compared to crop plants.

Harmful effects of weeds

1. Weeds compete with main crop for space, light, moistire and soil nutrients thus causing reduction in yield.
2. Affect quality of farm produce, livestock products such as milk and skin
3. Act as alternate host for pests and pathogens
4. Cause health problems to human beings eg; Parthenium causes allergy
5. Increase cost of cultivation due to weeding problem
6. Aquatic weeds transpire large quantity of water, obstruct flow of water
7. Reduce the land value (if cynodon, parthenium are present in the land)
8. Some weeds are poisonous to livestock.

Beneficial effects of weeds

1. Weed as soil binders
2. as manure
3. as human food
4. as fodder
5. Weed as fuel
6. Weed as mats and screens
7. Weed as medicine: Many weeds have great therapeutic properties and used as medicine. Eg.

Phyllanthus niruri	– Jaundice
Eclipta alba	– Scorpion sting
Centella asiatica	– Improves memory
Cynodon dactylon	– Asthma, piles
Cyperus rotundus	– Stimulates milk secretion

8. Weed as indicators: Weeds are useful as indicators of good and bad soils. Colonum occurs in rich soils while Cymbopogon denotes poor light soil and Sedges are found in ill-drained soils

- Genetically modified crops (GM crops, or biotech crops) are plants, the DNA of which has been modified using genetic engineering techniques, which are then used in agriculture.

Watershed Management

- A watershed is an area of land and water bounded by a drainage divide within which the surface runoff collects and flows out of the watershed through a single outlet into a lager river (or) lake.

Micro Irrigation

- Micro irrigation is defined as the methods in which low volume of water is applied at low pressure & high frequency. The system has extensive network of pipes at operated at low pressure. At pre-determined spacing outlets are provided for emission water generally known as emitters.

Sprinkler Irrigation

- In the sprinkler method of irrigation, water is sprayed into the air and allowed to fall on the ground surface somewhat resembling rainfall. The spray is developed by the flow of water under pressure through small orifices or nozzles.

Drip irrigation:

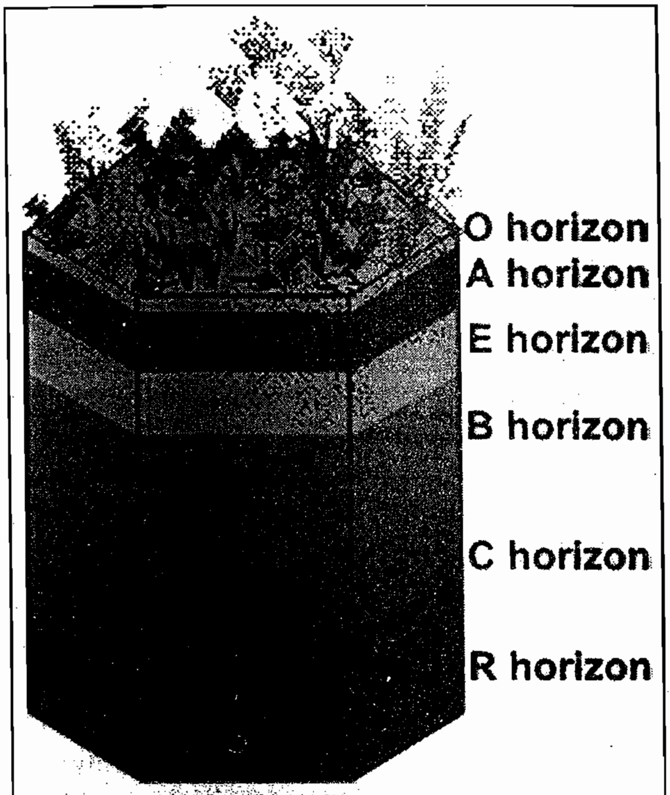
- Drip irrigation is also called trickle irrigation and involves dripping water onto the soil at very low rates from a system of small diameter plastic pipes fitted with outlets called emitters.
- Water is applied close to plants so that only part of the soil in which the roots grow is wetted, unlike surface and sprinkler irrigation, which involves wetting the whole soil profile.

Terracing:

- "A terrace is an embankment or ridge of earth constructed across a slope to control runoff and minimize soil erosion".
- It reduces the length of the hill side slope, thereby reducing sheet and rill erosion and prevents formation of gullies.

SOIL

- Soil is a natural body of mineral and organic constituents differentiated into horizons usually unconsolidated, of variable depth which differs among themselves as well as from the underlying parent material in morphology, physical makeup, chemical properties and composition and biological characteristics.
- Soil profile: The vertical section of the soil showing the various layers from the surface to the unaffected parent material is known as a soil profile. The various layers are known as horizons.
- There are 5 master horizons in the soil profile. Not all soil profiles contain all 5 horizons; and so, soil profiles differ from one location to another.



Soil Profile

- The 5 master horizons are represented by the letters: O, A, E, B, and C.
- **O:** The O horizon is a surface horizon that is comprised of organic material at various stages of decomposition. It is most prominent in forested areas where there is the accumulation of debris fallen from trees.
- **A:** The A horizon is a surface horizon that largely consists of minerals (sand, silt, and clay) and with appreciable amounts of organic matter. This horizon is predominantly the surface layer of many soils in grasslands and agricultural lands.
- **E:** The E horizon is a subsurface horizon that has been heavily leached. Leaching is the process in which soluble nutrients are lost from the soil due to precipitation or irrigation. The horizon is typically light in color. It is generally found beneath the O horizon.
- **B:** The B horizon is a subsurface horizon that has accumulated from the layer(s) above. It is a site of deposition of certain minerals that have leached from the layer(s) above.
- **C:** The C horizon is a subsurface horizon. It is the least weathered horizon. Also known as the saprolite, it is unconsolidated, loose parent material.
- **R:** Unweathered rock exists below the parent material.
- **Soil texture** refers to the relative proportion of particles or it is the relative percentage by weight of the three soil separates viz., sand, silt and clay or simply refers to the size of soil particles.
- **Loam** : A type of soil texture with good water holding capacity and drainage suitable for cultivation of variety of crops.
- **Soil structure:** The arrangement and organization of primary and secondary particles in a soil mass is known as soil structure.

Saline soils

- Saline soils are characterised by higher amount of water soluble salt, due to which the crop growth is affected.

Sodic soils

- Sodic soils are characterised by the predominance of sodium in the complex with the exchangeable sodium percentage exceeding 15 per cent and the pH more than 8.5.

Acid soils

- Acid soils are characteristically low in pH (<6.0). Predominance of H+ and Al3+ cause acidity resulting in deficiency of P, K, Ca, Mg, Mo and B.

Sandy soils

- Sandy soils are containing predominant amounts of sand resulting in higher percolation rates and nutrient losses.
- Alkaline soil: A soil with pH above 7, usually above 8.5 are considered alkaline. Alkaline soils often occur in arid regions that receive less than 25 inches of rain per year.
- Calcariuos soil- Soils with kankar nodules in the plough zone and subsoil.
- Alfisol: Soils with grey to brown surface horizons, medium to high supply of bases and B horizons of illuvial clay accumulation. These soils formed mostly under forest or savanna vegetation in climates with slight to pronounced seasonal moisture deficit.
- Aridisol: Minerals soils that have an aridic moisture regime. These are desert soil.

Podzolization:

- It is a process of soil formation resulting in the formation of Podzols and Podzolic soils.

- podzolization is the negative of calcification. The calcification process tends to concentrate calcium in the lower part of the B horizon, whereas podzolization leaches the entire solum of calcium carbonates.
- The other bases along with calcium are also removed and the whole soil becomes distinctly acidic. In fact, the process is essentially one of the processes of acid leaching.

Laterization:

- The term laterite is derived from the word later meaning brick or tile and was originally applied to a group of high clay Indian soils found in Malabar hills of Kerala, Tamil Nadu, Karnataka and Maharashtra.
- It refers specifically to a particular cemented horizon in certain soils which when dried, become very hard, like a brick.
- Laterization is the process that removes silica, instead of sesquioxides from the upper layers and thereby leaving sesquioxides to concentrate in the solum.

Gleization:

- It is a process of soil formation resulting in the development of a glei (or gley horizon) in the lower part of the soil profile above the parent material due to poor drainage condition (lack of oxygen) and where waterlogged conditions prevail. Such soils are called hydro orphic soils.

Salinization:

- It is the process of accumulation of salts, such as sulphates and chlorides of calcium, magnesium, sodium and potassium, in soils in the form of a salty (salic) horizon.
- It is quite common in arid and semi arid regions.
- It may also take place through capillary rise of saline ground water and by inundation with seawater in marine and coastal soils.
- Salt accumulation may also result from irrigation or seepage in areas of impeded drainage.

Desalinization:

- It is the removal of excess soluble salts by leaching from horizons or soil profile (that contained enough soluble salts to impair the plant growth) by ponding water and improving the drainage conditions by installing artificial drainage network.

Solonization or Alkalization:

- The process involves the accumulation of sodium ions on the exchange complex of the clay, resulting in the formation of sodic soils (Solonetz).
- All cations in solution are engaged in a reversible reaction with the exchange sites on the clay and organic matter particles.

Solodization or dealkalization:

- The process refers to the removal of Na+ from the exchange sites. This process involves dispersion of clay. Dispersion occurs when Na+ ions become hydrated.
- Much of the dispersion can be eliminated if Ca++ and or Mg++ ions are concentrated in the water, which is used to leach the soonest. These Ca and Mg ion can replace the Na on exchange complex, and the salts of sodium are leached out.

STAGES OF SOIL EROSION

Splash erosion

- Splash erosion is the first stage of the erosion process. It occurs when raindrops hit bare soil. The explosive impact breaks up soil aggregates so that individual soil particles are 'splashed' onto the soil surface.

Sheet erosion

- Sheet erosion refers to the uniform movement of a thin layer of soil across an expanse of land devoid of vegetative cover. Raindrops detach soil particles, which go into solution as runoff occurs and are transported downstream to a point of deposition.

Rill erosion

- When sheet flows begin to concentrate on the land surface, rill erosion occurs. While sheet erosion is generally invisible, rill erosion leaves visible scouring on the landscape. This type of erosion occurs when the duration or intensity of rain increases and runoff volumes accelerate.

Gully erosion

- Rill erosion evolves into gully erosion as duration or intensity of rain continues to increase and runoff volumes continue to accelerate. A gully is generally defined as a scoured out area that is not crossable with tillage or grading equipment.

- **Ammonification:** Production of ammonia as a result of the biological decomposition of organic nitrogen compounds.
- **Border cropping:** is growing of crops on the border areas of the plot or field
- Ex; Safflower as border crop in potato
- **Border strip irrigation:** It is an efficient method of irrigation close growing crops. In this method the field is divided by low flat levels into series of strips, each of which is flooded separately.
- **Allelopathy:** is defined as direct or indirect harmful effect of one plant over the other crop species through the exudation of toxic substances from the roots or the decomposition of crop residues
- **C:N ratio:** The ratio of the weight of organic C to the weight of total N in the soil.
- **Check basin:** It is a method of irrigation with beds and channel for retaining water to form a pond
- **Heaving:** Injury to plants caused by lifting upward of the plant along with soil from it's normal position in temperate regions where snowfall is common
- **Contour farming:** is the farming practice of ploughing across a slope following its elevation contour lines.
- **Cover crops:** crops which are grown to cover the soil in order to reduce the loss of the moisture from the soil due to leaching and erosion.
- **Critical stage of irrigation:** the period or the stage of development of lifecycle of the crop when it is most sensitive to moisture stress, results in yield loss
- **Hard pan :** It is a hard and impermeable layer formed in the soil profile by accumulation of materials such as salts, clay etc which impedes drainage
- **Growth regulators:** Organic substances which in minute amount may participate in the control of growth processes Ex :Auxins, Cytokinins
- **Heliophytes :** Plants of sun loving species, require intense light for normal development Ex: Rice, Wheat, Cotton, Sugarcane
- **Sciophytes :** Plants which are shade loving and require less light intensity
- **Heliotropism :** It is the movement of the plant parts towards the sun Ex: Sunflower
- **Geotropism:** A growth movement in response to gravity. Eg Groundnut peg penetration into the soil
- **Herbicide :** A chemical used for killing or inhibiting the growth of unwanted plants Ex: Atrazine
- **Insecticide :** It is the chemical used for killing the insects : Endosulfan
- **Hidden hunger :** Is the condition where plants do not exhibit visual symptoms of deficiency for the short supply of particular nutrients but will result in yield losses
- **Humus :** A brown or black organic substance consisting of partially or wholly decayed vegetable or animal matter that provides nutrients for plants and increases the ability of soil to retain water
- **Mulching :** Practice of covering the soil surface with materials like plant residues, straw, leaves or plastic film to reduce evaporation, restrict weed growth and maintain the soil temperature
- **Puddling :** It is the ploughing operation carried out in stagnated water conditions to create an impervious layer below the plough pan
- **Shifting cultivation :** It is the old practice of cutting and clearing of forest for cultivating crops for a certain period of time as long as the soils having fertility
- **Subsidiary farming :** Settled Farming in river banks and streams in addition to gathering & hunting
- **Subsistence farming :** Raising the crops only for family needs and not for commercial : "Grow it and eat it"

System of Rice Intensification (SRI)

- System of Rice Intensification (SRI) emerged in the 1980's as a synthesis of locally advantageous rice production practices encountered in Madagascar by Fr Henri de Laulanie
- SRI is a combination of several practices those include changes in nursery management, time of transplanting, water and weed management. It emphasizes altering of certain agronomic practices of the conventional way of rice cultivation. All these new practices are together known as System of Rice Intensification (SRI).
- Principle - 'More with Less'

- SRI is not a fixed package of technical specifications, but a system of production with four main components, viz., soil fertility management, planting method, weed control and water (irrigation) management. Rice yield increased with less water and with reduction in chemical inputs.

Sustainable Sugarcane Initiative (SSI)

- Sustainable Sugarcane Initiative (SSI) is an innovative set of agronomic practices that involves using less seeds, raising seeds in a nursery, and following new planting methods, with wider seed spacing, and better water and nutrient management to increase the cane yields significantly.
- SSI methods can increase sugarcane yields by at least 20% with 30% less water and a 25% reduction in chemical inputs.
- The SSI method of sugarcane cultivation was evolved from the principles of 'More with Less' followed in SRI (System of Rice Intensification) and introduced in India by the WWF-ICRISAT collaborative project in 2009.

◆◆◆◆◆◆

PART - V

CHAPTER - 22

ACTS AND POLCIES

22.1.WILD LIFE PROTECTION ACT 1972

- India is the first country in the world to have made provisions for the protection and conservation of environment in its constitution. On 5th June 1972, environment was first discussed as an item of international agenda in the U.N. Conference of Human Environment in Stockholm and thereafter 5th June is celebrated all over the world as World Environment Day.
- Soon after the Stockholm Conference our country took substantive legislative steps for environmental protection. The Wildlife (Protection) Act was passed in 1972, followed by the Water (Prevention and Control of Pollution) Act 1974, the Forest (Conservation) Act, 1980, Air (Prevention and Control of Pollution) Act, 1981 and subsequently the Environment (Protection) Act, 1986.

22.1.1. Constitutional Provisions

- The provisions for environmental protection in the constitution were made within four years of Stockholm Conference, in 1976, though the 42nd amendment as follows:
- Article-48-A of the constitution provides:
- "The state shall endeavour to protect and improve the environment and to safeguard forest and wildlife of the country."
- Article 51-A (g) Provides:
- It shall be duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife an to have compassion for living creatures."
- Thus our constitution includes environmental protection and conservation as one of our fundamental duties. Some of the important Acts passed by the Government of India are discussed here.

22.1.2. The Wildlife (Protection) Act of 1972

- The passing of the Wildlife Act of 1972 constitutes an important landmark in the history of wildlife legislation in the country.
- This is because of the fact that the "Forest" including "Wildlife" was then a State subject falling in Entry 20 List II of Seventh Schedule, Parliament had no power to make law on the same except as provided in Articles 249,250 and 252 of the constitution.
- Having regard to the importance of the matter, the Act has been adopted by all the States except that of Jammu and Kashmir which has a similar law enacted for the purpose of wildlife protection. The operation of the Act is mandatory in the Union Territories too.
- The Wildlife (Protection) Act of 1972 provides the basic framework to ensure the protection and management of wildlife. The Act was amended subsequently in 1982, 1986, 1991 and 1993 to accommodate provision for its effective implementation.

The rationale for passing Act as stated in its Statement of Objects and Reasons are as follows:

- The rapid decline of India's wild animals and birds, one of the richest and most varied wildlife resources of the country has been a cause of grave concern.
- Areas which were once teeming with wildlife have become devoid of it and even in sanctuaries and National Parks the protection afforded to wildlife needs to be improved.
- The Wild Birds and Animals Protection Act, 1935 has become completely outdated.
- This existing laws not only have become outdated but also provide punishments, which are not commensurate with the offence and financial benefits that occur from poaching and trade in wildlife produce. Further, such laws mainly relate to control of hunting and do not

emphasize the other factors which are also the prime reasons for the decline of India's wildlife namely taxidermy and trade in wildlife and products there from.

22.1.3. Salient features of the Act:

- The Wildlife Protection Act, 1972 is a product of process which started long ago in 1887 for the protection of a few wild birds and after addition of wild animals in 1912 and specified plants in 1919 it covered almost all the wildlife resources which need protection and management.

1. The Wildlife Act of 1972 as amended in 1982, 1986, 1991 and 1993 has 7 Chapters, 66 Sections and 6 Schedules. The Act with its various amendments provides the necessary tool to prevent damage to the wildlife.
2. The rating of the Schedules I to V is in accordance with the risk of survival of the wildlife (fauna) enlisted in them. Animals included Schedule are provided for total protection from hunting and the trade and commerce related to such animals are strictly regulated. The schedule VI has been added to include the specified plant species to be protected by the Wildlife (Protection) Amendment Act of 1991.
3. An expert committee, constituted by the Indian Board of Wildlife considers amendments to the Act, as and when necessary.
4. With the amendment of the Act in 1991, powers of the State Governments have been withdrawn almost totally. Now the State Governments are not empowered to declare any wild animal a vermin. Further by addition of provision, immunization of livestock within a radius of 5 km from a National Park or sanctuary has been made compulsory.

22.2. ENVIRONMENT (PROTECTION) ACT, 1986

- As compared to all other previous laws on environment protection, the Environment (Protection) Act, 1986 is a more effective and bold measure to fight the problem of pollution.
- The genesis of the Environmental (Protection) Act, 1986, thus, is in Article 48A (Directive Principles of State Policy) and Article 51A (g) (Fundamental Duties) of the Indian Constitution.
- Soon after the United Nations Conference on the Human Environment held at Stockholm in 1972, the Water (Prevention and Control of Pollution) Act, 1974 came on the statute book. The Air (Prevention and Control of Pollution) Act came in 1981 and finally came the Environment (Protection) Act, 1986.
- The Environment (Protection) Act, 1986 has 26 Sections and it has been divided into four chapters relating to i) Preliminary, ii) General Powers of the Central Government, iii) Prevention, Control, and Abatement of Environmental Pollution, iv) Miscellaneous.
- The Act consists of and deals with more stringent penal provisions. The minimum penalty for contravention or violation of any provision of the law is an imprisonment for a term which may extend to five years or fine up to one lakh rupees, or both. The Act also provides for the further penalty if the failure or contravention continues after the date of conviction. It is Rs. 5000/- per day. If the failure of contravention continues beyond the period of one year, then the offender is punished with imprisonment for a term which may extend to seven years.
- The Act empowers the Central Government to take all appropriate measures to prevent and control pollution and to establish effective machinery for the purpose of protecting and improving the quality of the environment and protecting controlling and abating environmental pollution.
- The Central Government or any other person duly authorised is empowered to collect the samples of air, water, soil or other substances as evidence of the offences under the Environment (Protection) Act, 1986.
- The Act prescribes a special procedure for handling hazardous substances and the concerned person has to handle the hazardous substances according to the procedure of the Act.
- The Environment (Protection) Act, 1986 has relaxed the rule of "Locus Standi" and because of such relaxation even a common citizen can approach the Court provided he has given a notice of sixty days of the alleged offence and his intention to make a complaint to the Central Government or any other competent authority.
- In the commission of the offence under this Act by Government Department, the Act holds the Head of the Department as guilty of the offence unless the head of the Department proves

that the offence was committed without his knowledge or that he exercised all due diligence to prevent the commission of such offence.

- This Act also empowers and authorises the Central Government to issue directions for the operation or process, prohibition, closure, or regulation of any industry. The Central Government is also authorised to stop, regulate the supply of electricity or water or any other service directly without obtaining the order of the Court in this regard.
- The Environment (Protection) Act, 1986 grants immunity to the officers of the Government for any act done under the provisions of this Act or under the powers vested in them or functions assigned to them under this Act.
- The Central Government is also empowered to enter and inspect any place through any person or through any agency authorised by Central Government.
- The Act debars the Civil Courts from having any jurisdiction to entertain any suit or proceeding in respect of an action, direction, order issued by Central Government or other statutory authority under this Act.
- Under the Act, there will be supremacy of provision. In other words, the provisions of this Act and the rules or orders made under this Act shall have effect and supremacy over anything inconsistent contained in any enactment other than this Act

22.3. NATIONAL FOREST POLICY 1988

- The principal aim of National Forest Policy, 1988 is to ensure environmental stability and maintenance of ecological balance including atmospheric equilibrium which are vital for sustenance of all life forms, human, animal and plant.

22.3.1. Objectives

- Maintenance of environmental stability through preservation and, where necessary, restoration of the ecological balance that has been adversely disturbed by serous depletion of the forests of the country.
- Conserving the natural heritage of the country by preserving the remaining natural forests with the vast variety of flora and fauna, which represent the remarkable biological diversity and genetic resources of the country.
- Checking soil erosion and denudation in the catchments areas of rivers, lakes, reservoirs in the "interest of soil and water conservation, for mitigating floods and droughts and for the retardation of siltation of reservoirs.
- Checking the extension of sand-dunes in the desert areas of Rajasthan and along the coastal tracts.
- Increasing substantially the forest/tree cover in the country through massive afforestation and social forestry programmes, especially on all denuded, degraded and unproductive lands.
- Meeting the requirements of fuel-wood, fodder, minor forest produce and small timber of the rural and tribal populations.
- Increasing the productivity of forests to meet essential national needs.
- Encouraging efficient utilisation of forest produce and maximising substitution of wood.
- Creating a massive people's movement with the involvement of women, for achieving these objectives and to minimise pressure on existing forests.

22.3.2. The major achievements of National Forest Policy, 1988,

- Increase in the forest and tree cover.
- Involvement of local communities in the protection, conservation and management of forests through Joint Forest Management Programme.
- Meeting the requirement of fuel wood, fodder minor forest produce and small timber of the rural and tribal populations.
- Conservation of Biological Diversity and Genetic Resources of the country through ex-situ and in-situ conservation measures.
- Significant contribution in maintenance of environment and ecological stability in the country.

22.4. BIOLOGICAL DIVERSITY ACT, 2002

- The Biological Diversity Act 2002 was born out of India's attempt to realize the objectives enshrined in the United Nations Convention on Biological Diversity (CBD) 1992 which recognizes the sovereign rights of states to use their own Biological Resources.

- An Act to provide for conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected therewith or incidental thereto.

22.4.1. Objectives

(i) Conservation of biological diversity;

(ii) Sustainable use of its components; and

(iii) Fair and equitable sharing of the benefits arising from the utilization of genetic resources.

- The Act envisages a three-tier structure to regulate access to the biological resources, comprising of National Biodiversity Authority (NBA), State Biodiversity Boards (SBB) and Biodiversity Management Committees (BMC) at the local level

22.5. THE SCHEDULED TRIBES AND OTHER TRADITIONAL FOREST DWELLERS (RECOGNITION OF FOREST RIGHTS) ACT, 2006

- Forest Rights Act, 2006 provides for the restitution of deprived forest rights across India, including both individual rights to cultivated land in forestland and community rights over common property resources.
- The Act is significant as it provides scope and historic opportunity of integrating conservation and livelihood rights of the people.

22.5.1. FRA is a potential tool

I. To empower and strengthen the local self governance

II. To address the livelihood security of the people

III. To address the issues of Conservation and management of the Natural Resources and conservation governance of India.

- For the first time Forest Rights Act recognises and secures

i. Community Rights in addition to their individual rights

ii. Right to protect, regenerate or conserve or manage any community forest resource which the communities have been traditionally protecting and conserving for sustainable use.

iii. Right to intellectual property and traditional knowledge related to biodiversity and cultural diversity

iv. Rights of displaced communities & Rights over developmental activities

22.5.2. Salient Features

- Nodal Agency for the implementation is MoTA.
- This Act is applicable for Tribal and Other Traditional Forest Dwelling Communities.
- The Act provides for recognition of forest rights of other traditional forest dwellers provided they have for at least three generations prior to 13.12.2005 primarily resided in and have depended on the forest or forest land for bonafide livelihood needs. A "generation" for this purpose would mean a period comprising of 25 years.
- The maximum limit of the recognizing rights on forest land is 4 ha.
- National Parks and Sanctuaries have been included along with Reserve Forest, Protected Forests for the recognition of Rights.
- The Act recognizes the right of ownership access to collect, use, and dispose of minor forest produce which has been traditionally collected within or outside village boundaries.
- The Act has defined the term "minor forest produce" to include all non-timber forest produce of plant origin, including bamboo, brush wood, stumps, cane, tussar, cocoons, honey, wax, lac, tendu or kendu leaves, medicinal plants and herbs, roots, tubers and the like.
- The Act provides for the forest right relating to Government providing for diversion of forest land for the purpose of schools, hospitals, anganwadis, drinking water supply and water pipelines, roads, electric and telecommunication lines, etc.
- The rights conferred under the Act shall be heritable but not alienable or transferable and shall be registered jointly in the name of both the spouses in the case of married persons and in the name of the single head, in the case of a household headed by a single person and in the absence of a direct heir, the heritable right shall pass on to the next of kin

- The Act provides that no member of a forest dwelling Scheduled Tribe or other traditional forest dwellers shall be evicted or removed from forest land under his occupation till the recognition and verification procedure is completed.
- As per the Act, the Gram Sabha has been designated as the competent authority for initiating the process of determining the nature and extent of individual or community forest rights or both that may be given to the forest dwelling Scheduled Tribes and other traditional forest dwellers.

22.6. COASTAL REGULATION ZONE (CRZ)

- The coastal stretches of seas, bays, estuaries, creeks, rivers and back waters which are influenced by tidal action up to 500 meters from the High Tide Line (HTL) and the land between the Low Tide Line (LTL) and the HTL are declared "Coastal Regulation Zone" (CRZ), on 19.2.1991.
- The Notification on Coastal Regulation Zone (CRZ), 1991 (as amended from time to time) aims at protecting coastal stretches in India.
- India has created institutional mechanisms such as National Coastal Zone Management Authority (NCZMA) and State Coastal Zone Management Authority (SCZMA) for enforcement and monitoring of the CRZ Notification.
- These authorities have been delegated powers under Section 5 of the Environmental (Protection) Act, 1986 to take various measures for protecting and improving the quality of the coastal environment and preventing, abating and controlling environmental pollution in coastal areas.

22.6.1. Classification Criteria and Regulatory Norms:

- The coastal regulation zone has been classified for the purpose of regulation of the permitted activities.

CRZ-I:

- Ecological sensitive area and the area between High Tide Line (HTL) and Low Tide Line (LTL).
- No new construction is permitted except for a few specified most essential activities like support activities for Atomic Energy Plants and Defense requirements, facilities required for disposal of treated effluents and other port related water front activities.

CRZ-II:

- The area that have been developed up to or close to the shore line which includes the designated urban areas that are substantially built up.
- Buildings permitted only on the landward side of the existing road (or roads approved in the coastal zone Management Plan of the area) or on the landward side of the existing authorized structures as defined in the notification.
- Reconstruction of the authorized buildings permitted subject to existing FSI/FAR norms without change in the use.

CRZ-III:

- The areas that are relatively undisturbed and those which do not belong to either CRZ-I or CRZ-II which includes mainly the rural area and those not substantially built up within designated urban areas.
- The area up to 200 meters from HTL is earmarked as "No Development Zone".
- No construction is permitted within this zone except for repairs to the existing authorized structures without exceeding existing FSI, plinth area and density.
- Development of vacant plots between 200 and 500 meters of HTL is permitted in CRZ III for the purpose of construction of dwelling units and hotels/beach resorts subject to certain conditions.

CRZ-IV

- The activities impugning on the sea and tidal influenced water bodies will be regulated except for traditional fishing and related activities undertaken by local communities as follows:-

(a) No untreated sewage, effluents, ballast water, ship washes, fly ash or solid waste from all activities including from aquaculture operations shall be let off or dumped. A comprehensive plan for treatment of sewage generating from the coastal towns and cities shall be formulated within a period of one year in consultation with stakeholders including traditional coastal communities, traditional fisherfolk and implemented;

(b) Pollution from oil and gas exploration and drilling, mining, boat house and shipping;

(c) There shall be no restriction on the traditional fishing and allied activities undertaken by local communities.

22.7. WETLANDS (CONSERVATION AND MANAGEMENT) RULES 2010

- The Ministry of Environment and Forests has notified the Wetlands (Conservation and Management) Rules 2010 in order to ensure that there is no further degradation of wetlands.
- The rules specify activities which are harmful to wetlands such as industrialization, construction, dumping of untreated waste and reclamation and prohibit these activities in the wetlands.
- Other activities such as harvesting and dredging may be carried out in the wetlands but only with prior permission from the concerned authorities.
- Under the Rules, wetlands have been classified for better management and easier identification.
- Central Wetland Regulatory Authority has been set up to ensure proper implementation of the Rules and perform all functions for management of wetlands in India.
- Apart from necessary government representatives, the Authority shall have a number of expert members to ensure that wetland conservation is carried out in the best possible manner.
- The Wetlands (Conservation and Management) Rules, 2010 is a positive step towards conservation of wetlands in India. This will go a long way in protecting our wetlands which are under severe threat.

22.8. NATIONAL GREEN TRIBUNAL (NGT)

- The Preamble of the act provides for the establishment of a National Green Tribunal for the effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources, including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto (The National Green Tribunal Act, 2010).
- With the establishment of the NGT, India has joined the distinguished league of countries that have a dedicated adjudicatory forum to address environmental disputes.
- India is third country in the world to full fleged green tribunal followed by new Zealand and Australia.
- The specialized architecture of the NGT will facilitate fast track resolution of environmental cases and provide a boost to the implementation of many sustainable development measures.
- NGT is mandated to dispose the cases within six months of their respective appeals.
- [For more details on national green tribunal refer Shankar IAS academy's polity part II material]

22.9. THE OZONE DEPLETING SUBSTANCES RULES

- The Ozone Depleting Substances (Regulation and Control)Rules, 2000 under the Environment (Protection)Act, in July 2000.
- These Rules set the deadlines for phasing out of various ODSs, besides regulating production, trade import and export of ODSs and the product containing ODS.
- The Ozone Depleting Substances (Regulation and Control) Rule, 2000 were amended in 2001, 2003, 2004 and 2005 to facilitate implementation of ODS phase-out at enterprises in various sectors.
- These Rules prohibit the use of CFCs in manufacturing various products beyond 1st January 2003
- except in metered dose inhaler and for other medical purposes.
- Similarly, use of halons is prohibited after 1st January 2001 except for essential use. Other ODSs such as carbon tetrachloride and methylchoroform and CFC for metered dose inhalers can be used upto 1st January 2010.
- Further, the use of methyl bromide has been allowed upto 1st January 2015. Since HCFCs are used as interim substitute to replace CFC, these are allowed upto 1st January 2040.

◆◆◆◆◆◆

CHAPTER - 23

INSTITUTIONS AND MEASURES

NATIONAL WILDLIFE ACTION PLAN

- The first National Wildlife Action Plan (NWAP) was adopted in 1983, based upon the decision taken in the XV meeting of the Indian Board for Wildlife held in 1982. The plan had outlined the strategies and action points for wildlife conservation which are still relevant.
- In the meanwhile, however, some problems have become more acute and new concerns have become apparent, requiring a change in priorities. Increased commercial use of natural resources, continued growth of human and livestock populations and changes in consumption patterns are causing greater demographic impacts. Biodiversity conservation has thus become a focus of interest. The National Forest Policy was also formulated in 1988, giving primacy to conservation. Hence this new National Wildlife Action Plan.
- The first National Wildlife Action Plan (NWAP) of 1983 has been revised and the new Wildlife Action Plan (2002-2016) has been adopted.

Strategy for Action

- Adopting and implementing strategies and needs outlined above will call for action covering the following parameters:

I Strengthening and Enhancing the Protected Area Network

II Effective Management of Protected Areas

III Conservation of Wild and Endangered Species and Their Habitats

IV Restoration of Degraded Habitats outside Protected Areas

V Control of Poaching, Taxidermy and Illegal Trade in Wild Animal and Plant Species

VI Monitoring and Research

VII Human Resource Development and Personnel Planning

VIII Ensuring Peoples' Participation in Wildlife Conservation

IX Conservation Awareness and Education

X Wildlife Tourism

XI Domestic Legislation and International Conventions

XII Enhancing Financial Allocation for Ensuring Sustained Fund Flow to the Wildlife Sector

XIII Integration of National Wildlife Action Plan with Other Sectoral Programmes

NATIONAL AFFORESTATION AND ECO-DEVELOPMENT BOARD

- The Ministry of Environment and Forests constituted the National Afforestation and Eco-development Board (NAEB) in August 1992. National Afforestation and Eco-development Board has evolved specific schemes for promoting afforestation and management strategies, which help the states in developing specific afforestation and management strategies and eco-development packages for augmenting biomass production through a participatory planning process of Joint Forest Management and microplanning

National Afforestation Programme

- A National Afforestation Programme (NAfP) was launched in 2002, which involves plantation in degraded forests of the country.
- NAfP is a flagship programme of National Afforestation and Eco-development Board (NAEB) and provides physical and capacity building support to the Forest Development Agencies (FDAs), which are the implementing agencies.

COMPENSATORY AFFORESTATION FUND MANAGEMENT AND PLANNING AUTHORITY (CAMPA)

- In April 2004, the central government, under the orders of the Supreme Court, constituted the Compensatory Afforestation Fund Management and Planning Authority (CAMPA) for the management of money towards compensatory afforestation, and other money recoverable, in compliance of the conditions stipulated by the central government and in accordance with the Forest (Conservation) Act,
- CAMPA as envisaged by the Supreme Court of India vide its order dated 29/30.10.2002, could not become operational due to non-passing of Compensatory Afforestation Fund Bill 2008 in the Parliament.
- However, as on jan 2010, an amount of Rs.11,378 crores has been deposited in Ad-hoc CAMPA by various project proponents towards the diversion of forest land for non-forestry purposes under the Forest (Conservation) Act, 1980.
- These remittances relate to Compensatory Afforestation (CA), Additional Compensatory Afforestation (ACA), Penal Compensatory Afforestation (PCA), Catchment Area Treatment (CAT) Plan, Protected Area Management and Net Present Value (NPV) etc.
- The Central Government with the concurrence of the Supreme Court of India formulated the guidelines in consultation with the States/Union Territories to utilize the money deposited in Ad-hoc CAMPA by establishing State CAMPAs.
- As per these guidelines and the Supreme Court order, a sum of Rs.1000 crores per year, for the 5 years, shall be released to the State CAMPAs in proportion of 10% of the principal amount deposited by the States/Union Territories in Ad-hoc CAMPA.

JOINT FOREST MANAGEMENT (JFM)

- JFM is an initiative to institutionalize participatory governance of country's forest resources by involving the local communities living close to the forest.
- This is a co-management institution to develop partnerships between forest fringe communities and the Forest Department (FD) on the basis of mutual trust and jointly defined roles and responsibilities with regard to forest protection and regeneration.
- JFM started in consonance with the National Forest Policy 1988, which has recognized the importance of involving the local communities and the government has issued necessary resolutions and guidelines subsequently to initiate such institutions and strengthen it further.
- Most of the states in India have adopted JFM and issued resolutions permitting such partnership as per the prescribed guidelines though the institutional structure varies across the states.
- Under JFM, both forest departments and local communities come to an agreement to form the committee to manage and protect forests by sharing the costs and benefits.
- Forest departments take the initiative to form such committees directly by talking to the local community or through the help of NGOs working in specific areas.
- NGOs are also involved for capacity building, information dissemination, monitoring and evaluation and often act as the facilitators in constituting these participatory institutions.
- One of the key objectives of the JFM programme is the rehabilitation of degraded forestlands with people's participation involving Forest Protection Committees.
- JFM brings a win-win situation for both forest departments as well as the local communities in terms of greater access to minor forest produces from these regenerated forests.

SOCIAL FORESTRY

- The National Commission on Agriculture, Government of India, first used the term 'social forestry' in 1976.
- It was then that India embarked upon a social forestry project with the aim of taking the pressure off the forests and making use of all unused and fallow land.

- Government forest areas that are close to human settlement and have been degraded over the years due to human activities needed to be afforested.
- Trees were to be planted in and around agricultural fields. Plantation of trees along railway lines and roadsides, and river and canal banks were carried out. They were planted in village common land, Government wasteland and Panchayat land.

5 F's

- Social forestry also aims at raising plantations by the common man so as to meet the growing demand for food, fuel wood, fodder, fiber and fertilizer etc, thereby reducing the pressure on the traditional forest area.
- With the introduction of this scheme the government formally recognised the local communities' rights to forest resources, and encouraged rural participation in the management of natural resources. Through the social forestry scheme, the government has involved community participation, as part of a drive towards afforestation, and rehabilitating the degraded forest and common lands.

Social forestry scheme can be categorized into groups

Farm forestry

- Individual farmers are being encouraged to plant trees on their own farmland to meet the domestic needs of the family.
- Non-commercial farm forestry is the main thrust of most of the social forestry projects in the country today.
- It is to provide shade for the agricultural crops; as wind shelters; soil conservation or to use wasteland.

Community forestry

- It is the raising of trees on community land and not on private land as in farm forestry. All these programmes aim to provide for the entire community and not for any individual. The government has the responsibility of providing seedlings, fertilizer but the community has to take responsibility of protecting the trees.

Extension forestry

- Planting of trees on the sides of roads, canals and railways, along with planting on wastelands is known as 'extension' forestry, increasing the boundaries of forests. Under this project there has been creation of wood lots in the village common lands, government wastelands and panchayat lands.
- Recreational forestry
- Raising of trees with the major objective of recreation alone.

NATIONAL BAMBOO MISSION

- The National Bamboo Mission is a Centrally Sponsored Scheme with 100% contribution from Central Government. It is being implemented by the Horticulture Division under Department of Agriculture and Co-operation in the Ministry of Agriculture, New Delhi.
- Bamboo Mission envisages integration of different Ministries/Departments and involvement of local people/initiatives for the holistic development of bamboo sector in terms of growth of bamboo through increase in area coverage, enhanced yields and scientific management, marketing of bamboo and bamboo based handicrafts, generation of employment opportunities etc.

Objectives of the Mission

- To promote the growth of bamboo sector through an area based regionally differentiated strategy;
- To increase the coverage of area under bamboo in potential areas, with suitable species to enhance yields;
- To promote marketing of bamboo and bamboo based handicrafts;
- To establish convergence and synergy among stakeholders for the development of bamboo;
- To promote, develop and disseminate technologies through a seamless blend of traditional wisdom and modern scientific knowledge;
- To generate employment opportunities for skilled and unskilled persons, especially unemployed youths.

Strategy of the Mission

- Adopt a coordinated approach covering production and marketing to assure appropriate returns to growers/ producers.

- Promote Research and Development (R&D) of genetically superior clones of suitable species and technologies for enhanced production.
- Enhance acreage (in forest and non-forest areas) and productivity of bamboo through species change and improved cultural practices.
- Promote partnership, convergence and synergy among R&D and marketing agencies in public as well as private sectors, at all levels.
- Promote where appropriate, cooperatives and self-help groups to ensure support and adequate return to farmers.
- Facilitate capacity-building and Human Resource Development.
- Set up National, State and sub-State level structures, to ensure adequate returns for the produce of the farmers and eliminate middlemen, to the extent possible.

COMPREHENSIVE ENVIRONMENTAL POLLUTION INDEX (CEPI)

- Comprehensive Environmental Pollution Index (CEPI) is a rational number to characterize the environmental quality at a given location following the algorithm of source, pathway, receptor and various parameters like pollutant concentration, impact on human health and level of exposure have been taken into consideration for the calculation of pollution indices for air, water and land.
- The present CEPI is intended to act as an early warning tool. It can help in categorizing the industrial clusters in terms of priority of planning needs for interventions.

Classification of industrial clusters:

CEPI score	status	measures
> 70	critically polluted	detailed investigations and appropriate remedial action
60 – 70	severely polluted	surveillance and implementation of pollution control
< 60	normal	

- The Central and state Pollution Control Board, in collaboration with IIT, Delhi has applied the CEPI for environmental assessment of 88 Industrial Clusters across the country. 43 such industrial clusters having CEPI greater than 70, on a scale of 0 to 100, have been identified as critically polluted.
- The effective implementation of the remedial action plan will help in pollution abatement and to restore the environmental quality of respective industrial clusters and its sustainable use.
- The polluted industrial clusters/areas shall be further explored in order to define the spatial boundaries as well as the extent of eco-geological damages.
- The outcome shall be subjected to structured consultation with the stakeholders for determining comparative effectiveness of alternative plans and policies.
- there are still some aspects that need to be improved include, consistency in pollution monitoring data, selection of sampling locations for the environmental monitoring, and collection of data on adverse impact on human population and other geo-ecological features due to industrial pollution.

LIGHTING A BILLION LIVES (LABL)

- LaBL is a campaign by TERI that promotes the use of solar lanterns specially designed and manufactured on a decentralized basis.
- LaBL has been able to engage with government interventions under Sarva Shiksha Abhiyan, Madhya Pradesh Rural Livelihood Project, Rasthriya Gramin Vikas Nidhi, and has facilitated the spread of mobile telephony with support from Department of Telecommunications, Government of India.
- LaBL has successfully engaged the private sector and leveraged Corporate Social Responsibility (CSR).
- This initiative has the potential to contribute towards the realization of the Millennium Development Goals (MDGs) by improving energy access for the rural poor.
- Formation of more than 100 women-led Self Help Groups (SHGs), and strengthening of around 150 SHGs are among the impacts of this initiative.

- The campaign has demonstrated how Public-Private-People partnerships can support rural development schemes, particularly in the areas of health, education, environment and women's empowerment.
- The campaign has drawn support from public sector units and corporates, among its various partners, to aid the execution of the programme at the scale at which it exists today.

ECO MARK

- a government scheme of labeling of environment friendly products to provide accreditation and labelling for household and other consumer products which meet certain environmental criteria along with quality requirements of the Bureau of Indian Standards for that product.
- Objective - to recognize good environmental performance as well as improvements in performance of the unit
- Any product, which is made, used or disposed of in a way that significantly reduces the harm to environment, could be considered as 'Environment Friendly Product'.
- The project would help in capacity building by conducting training, workshops, seminars, conference etc. on the issues pertaining to the industry and environment interface. This would facilitate the change in attitude of the stakeholders and the industry on the need to support the proactive industry.

URBAN SERVICES ENVIRONMENTAL RATING SYSTEM (USERS)

- Project funded by UNDP executed by Ministry of Environment and Forests and implemented by TERI.
- Aim - to develop an analytical tool to measure the performance, with respect to delivery of basic services in local bodies of Delhi and Kanpur. (identified as pilot cities).
- Performance measurement (PM) tool was developed through a set of performance measurement indicators that are benchmarked against set targets using the inputs-outputs efficiency outcomes framework.

BIODIVERSITY CONSERVATION & RURAL LIVELIHOOD IMPROVEMENT PROJECT (BCRLIP)

- Aim - conserving Biodiversity in selected landscapes, including wildlife protected areas/ critical conservation areas while improving rural livelihoods through participatory approaches.
- Development of Joint Forest Management (JFM) and eco-development in some states are models of new approaches to provide benefits to both conservation and local communities.
- The project intends to expand to other globally significant sites in the country to strengthen linkages between conservation and improving livelihoods of local communities that live in the neighborhood of biodiversity rich areas-as well as to enhance the local and national economy.
- The Project would be implemented as a Centrally Sponsored Scheme with five financiers (IDA loan, GEF grant, contributions from Government of India, State Governments and beneficiaries), amounting to around Rs. 137.35 crores, spread over six years.

NATIONAL CLEAN ENERGY FUND

- 'National Clean Energy Fund' (NCEF) was constituted in the public account of India in the Finance Bill 2010-11.
- Objective - to invest in entrepreneurial ventures and research & innovative projects in the field of clean energy technology.
- The Central Board of Excise and Customs consequently notified the Clean Energy Cess Rules 2010 under which producers of specified goods namely raw coal, raw lignite and raw peat were made liable to pay Clean Energy Cess.
- Any project with innovative methods to adopt to clean energy technology and research & development shall be eligible for funding under the NCEF.
- Government assistance under the NCEF shall in no case exceed 40% of the total project cost.
- Indo-French Project to Study Effects of Climate Change on Farming
- The Indo-French Centre for the Promotion of Advanced Research (CEFIPRA) launched a multi-disciplinary Indo-French research project titled 'Adaptation of Irrigated Agriculture to Climate Change (AICHA).'

- The study aims at developing an integrated model for analysing the impact of climate change on ground water-irrigated agriculture in south India.
- Berambadi village and surrounding areas in Hangla hobli of Gundlupet taluk in Chamaraja nagar district have been selected for a field study under the project.
- The project would explore adaptation strategies based on innovative cropping systems and water resource management policies, by considering a range of scenarios for agricultural systems and policies, to be tested at the farm and the watershed scale.
- The methodology will combine remote sensing, field surveys and advanced numerical analysis with hydrological, agronomical and economic modeling, and will pay particular attention to sustainability and acceptability issues.

NATIONAL MISSION FOR ELECTRIC MOBILITY

- A National Mission for Electric Mobility (NCEM) to promote electric mobility and manufacturing of electric vehicles in India.
- The setting up of NCEM has been influenced by the following three factors:
- 1.Fast dwindling petroleum resources
- 2.Impact of vehicles on the environment and climate change
- 3.Worldwide shift of the automobile industry towards more efficient drive technologies and alternative fuels including electric vehicles

Barriers

- Higher cost of Electric Vehicles, Challenges in battery technology, Consumer mindset, Inadequate government support
- Objective to resolve these barriers by providing government intervention/support, adoption of mission mode approach for fast decision making and ensuring collaboration amongst various stakeholders.
- The NCEM will be the apex body in the Government of India for making recommendations in these matters.

SCIENCE EXPRESS - BIODIVERSITY SPECIAL (SEBS)

- SEBS is an innovative mobile exhibition mounted on a specially designed 16 coach AC train, traveling across India from 5 June to 22 December 2012 (180 days) to create widespread awareness on the unique biodiversity of the country.
- SEBS is the fifth phase of the iconic and path-breaking Science Express.
- The SEBS is a unique collaborative initiative of Department of Science & Technology (DST) and Ministry of Environment & Forests (MoEF), Government of India.
- The state-of-the-art exhibition aboard SEBS aims to create wide-spread awareness on the unique biodiversity of India, Climate Change, Water, Energy Conservation and related issues among various sections of the society, especially students.

ENVIRONMENT EDUCATION, AWARENESS & TRAINING (EEAT) SCHEME

- EEAT a Central Scheme launched during the 6th Five Year Plan in 1983-84 with the following objectives:

1. To promote environmental awareness among all sections of the society.
2. To spread environment education, especially in the non-formal system.
3. To facilitate development of education/training materials and aids in the formal education sector.
4. To promote environment education through existing educational/scientific institutions.
5. To ensure training and manpower development for EEAT.
6. To encourage NGOs, mass media and other concerned organizations for promoting awareness about environmental issues.
7. To use different media (audio & visual) for spreading messages concerning environment and awareness and
8. To mobilize people's participation for preservation and conservation of environment.

NATIONAL ENVIRONMENT AWARENESS CAMPAIGN (NEAC)

- The NEAC was launched in 1986 with the objective of creating environmental awareness at the national level.
- It is a multi-media campaign which utilises conventional and non-conventional methods of communication for disseminating environmental messages.
- Under this campaign, nominal financial assistance is provided to registered NGOs, schools, colleges, universities, research institutions, women and youth organisations, army units, State Government Departments etc. from all over the country for organising/ conducting awareness raising activities.
- These activities which include seminars, workshops, training programmes, camps, rallies, exhibitions, competitions, folk dances and songs, street theatre, puppet shows, preparation and distribution of environmental education resource materials etc., are followed by action like plantation of trees, management of household waste, cleaning of water bodies etc.

ECO-CLUBS (NATIONAL GREEN CORPS)

- The main objectives of this programme are to educate children about their immediate environment and impart knowledge about the eco-systems, their inter-dependence and their need for survival, through visits and demonstrations and to mobilise youngsters by instilling in them the spirit of scientific inquiry into environmental problems and involving them in the efforts of environmental preservation.
- Global Learning and Observations to Benefit the Environment (GLOBE)
- The GLOBE is an International Science and Education Programme, which stress on hands-on participatory approach. India joined this programme during the August, 2000.
- This programme, which unites students, teachers and scientists all over the world, is aimed at school children.
- The students of GLOBE schools are required to collect data about various basic environmental parameters under the supervision of a GLOBE trained teacher and use it for explaining hypothesis as well as to enhance their scientific understanding of the earth.

MANGROVES FOR THE FUTURE

- Mangroves for the Future are a partnership-based initiative promoting investment in coastal ecosystems for sustainable development.

Mission

- to promote healthy coastal ecosystems through a partnership-based, people-focused, policy-relevant and investment-orientated approach, which builds and applies knowledge, empowers communities and other stakeholders, enhances governance, secures livelihoods, and increases resilience to natural hazards and climate change.
- Member countries: India, Indonesia, Maldives, Pakistan, Seychelles, Sri Lanka, Thailand, Viet Nam. Outreach countries: Bangladesh, Cambodia, Myanmar, Timor-Leste. Dialogue countries: Kenya, Malaysia, Tanzania.
- MFF provides a collaborative platform to help countries, sectors and agencies in the MFF region tackle the growing challenges to coastal sustainability.
- MFF has adopted mangroves as its flagship ecosystem in recognition of the important role that mangrove forests played in reducing the impact of the 2004 Indian Ocean tsunami, and the severe effect on coastal livelihoods caused by the loss and degradation of mangroves.
- However MFF embraces all coastal ecosystems, including coral reefs, estuaries, lagoons, wetlands, beaches and seagrass beds.

◆◆◆◆◆◆

CHAPTER - 24

ORGANIZATIONS

THE ANIMAL WELFARE BOARD OF INDIA

- The Animal Welfare Board of India is a statutory advisory body on Animal Welfare Laws and promotes animal welfare in the country.
- The Animal Welfare Board of India, the first of its kind to be established by any Government in the world, was set up in 1962, in accordance with Section 4 of the Prevention of Cruelty to Animals Acts 1960.
- Shrimati Rukmini Devi Arundale pioneered the setting up of the Board, with its Headquaters at Chennai. She guided the activities of the Board for nearly twenty years till her demise in 1986.

Functions

- To keep the law in force in India for the Prevention of Cruelty to Animals under constant study and to advise the government on the amendments to be undertaken in any such law from time to time.
- To advise the Central Government on the making of rules under the Act with a view to preventing unnecessary pain or suffering to animals generally, and more particularly when they are being transported from one place to another or when they are used as performing animals or when they are kept in captivity or confinement.
- To advise the Government or any local authority or other person on improvements in the design of vehicles so as to lessen the burden on draught animals.
- To take all such steps as the Board may think fit for amelioration of animals by encouraging, or providing for the construction of sheds, water troughs and the like and by providing for veterinary assistance to animals.
- To advise the Government or any local authority or other person in the design of slaughter houses or the maintenance of slaughter houses or in connection with slaughter of animals so that unnecessary pain or suffering, whether physical or mental, is eliminated in the pre- slaughter stages as far as possible, and animals are killed, wherever necessary, in as humane a manner as possible.
- To take all such steps as the Board may think fit to ensure that unwanted animals are destroyed by local authorities, whenever it is necessary to do so, either instantaneously or after being rendered insensible to pain or suffering.
- To encourage by the grant of financial assistance or otherwise, the formation or establishment of Pinjarapoles, rescue homes, animals shelters, sanctuaries and the like, where animals and birds may find a shelter when they have become old and useless or when they need protection.
- To co-operate with, and co-ordinate the work of associations or bodies established for the purpose of preventing unnecessary pain or suffering to animals or for the protection of animals and birds.
- To give financial assistance and other assistance to Animal Welfare Organisations, functioning in any local area or to encourage the formation of Animal Welfare Organisations in any local area which shall work under the general supervision and guidance of the Board.
- To advise the Government on matters relating to the medical care and attention which may be provided in animal hospitals, and to give financial and other assistance to animal hospitals whenever the Board think it is necessary to do so.
- To impart education in relation to the humane treatment of animals and to encourage the formation of public opinion against the infliction of unnecessary pain or suffering to animals and for the promotion of animal welfare by means of lectures books, posters, cinematographic exhibitions and the like.

- To advise the Government on any matter connected with animal welfare or the Prevention of infliction of unnecessary pain or suffering on animals.
- The Board consists of 28 Members. The term of office of Members is for a period of 3 years.

CENTRAL ZOO AUTHORITY

- The amendment made to the Wild Life (Protection) Act in 1991 added a new chapter dealing with zoos to the Act and allowed for the Central Government to constitute an authority known as the Central Zoo Authority to oversee the functioning and development of zoos in the country. According to the provisions of this chapter, only such zoos which were operated in accordance with the norms and standards prescribed by the Central Zoo Authority would be granted 'recognition' to operate by the Authority.

Functions

- The following are the functions of the Central Zoo Authority as specified in the Act:

1. To specify the minimum standards for housing, upkeep and veterinary care of animals kept in a zoo
2. To evaluate and assess the functioning of zoos with respect to the standards or the norms as are prescribed
3. To recognize and derecognize zoos.
4. To identify endangered species of wild animals for purposes of captive breeding and assigning responsibility in this regard to a zoo
5. To co-ordinate the acquisition, exchange and loaning of animals for breeding purposes
6. To ensure maintenance of stud-books of endangered species of wild animals bred in captivity
7. To identify priorities and themes with regard to display of captive animals in a zoo
8. To co-ordinate training of zoo personnel in India and abroad
9. To co-ordinate research in captive breeding and educational programs for the purposes of zoos
10. To provide technical and other assistance to zoos for their proper management and development on scientific lines
11. To perform such other functions as may be necessary to carry out the purposes of this Act with regard to zoos

Powers

- Recognition of zoos
- Permission for acquisition of wild / captive animals
- Cognizance of offences
- Grant of licences, certificate of ownership, recognition, etc

THE NATIONAL BIODIVERSITY AUTHORITY (NBA) – CHENNAI.

- The National Biodiversity Authority (NBA) was established in 2003 to implement India's Biological Diversity Act (2002).
- The NBA is a Statutory, Autonomous Body and it performs facilitative, regulatory and advisory function for the Government of India on issues of conservation, sustainable use of biological resources and fair and equitable sharing of benefits arising out of the use of biological resources.

Objectives of the NBA

- Anybody seeking any kind of intellectual property rights on a research based upon biological resource or knowledge obtained from India has to obtain prior approval of the NBA.
- The NBA will impose benefit-sharing conditions.
- For ensuring equitable sharing of benefits arising from the use of biological resources and associated knowledge, Sections 19 and 21 stipulate prior approval of the National Biodiversity Authority (NBA) before their access.
- Ensures protection to the knowledge of local people relating to biodiversity through measures such as registration of such knowledge.

Main functions:

(1) The National Biodiversity Authority may-
   (a) advise the Central Government on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of benefits arising out of the utilization of biological resources;
   (b) advise the State Governments in the selection of areas of biodiversity importance to be notified as heritage sites and measures for the management of such heritage sites;
   (c) perform such other functions as may be necessary to carry out the provisions of this Act.

(2) The National Biodiversity Authority may, on behalf of the Central Government, take any measures necessary to oppose the grant of intellectual property rights in any country outside India on any biological resource obtained from India or knowledge associated with such biological resource which is derived from India.

Transfer of biological resource or knowledge

- No person who has been granted approval, shall transfer any biological resource or knowledge associated to others except with the permission of the National Biodiversity Authority
- The National Biodiversity Authority grants approval for transfer, after making enquiries subject to certain terms and conditions including the imposition of charges by way of royalty or for reasons to be recorded in writing, reject the application.
- The NBA gives public notice of approval granted under this section

The State Biodiversity Boards (SBBs)

- The State Biodiversity Boards (SBBs) focus on advising the State Governments on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of the benefits arising out of the utilization of biological resources;
- The SSBs also regulate, by granting of approvals or otherwise requests for commercial utilization or bio-survey and bio-utilization of any biological resource by Indians.
- The local level Biodiversity Management Committees (BMCs)
- The local level Biodiversity Management Committees (BMCs) are responsible for promoting conservation, sustainable use and documentation of biological diversity and chronicling of knowledge relating to biological diversity.

WILDLIFE CRIME CONTROL BUREAU (WCCB)

- The Government of India constituted a statutory body, the Wildlife Crime Control Bureau on 6th June 2007, by amending the Wildlife (Protection) Act, 1972. The bureau would complement the efforts of the state governments, primary enforcers of the Wildlife (Protection) Act, 1972 and other enforcement agencies of the country.

Functions

(i) Collection, collation of intelligence and its dissemination and establishment of a centralized Wildlife Crime data bank;

(ii) Co-ordination of actions by various enforcement authorities towards the implementation of the provisions of this Act.

(iii) Implementation of obligations under the various international Conventions and protocols

(iv) Assistance to concerned authorities in foreign countries and concerned international organizations to facilitate co-ordination and universal action for wildlife crime control;

(v) Development of infrastructure and capacity building for scientific and professional investigation;

(vi) Advice the Government of India on issues relating to wildlife crimes having national and international ramifications, and suggest changes required in relevant policy and laws from time to time.

NATIONAL LAKE CONSERVATION PLAN (NLCP)

- Ministry of Environment and Forests has been implementing the National Lake Conservation Plan (NLCP) since 2001 for conservation and management of polluted and degraded lakes in urban and semi-urban areas

Objective

- to restore and conserve the urban and semi-urban lakes of the country degraded due to waste water discharge into the lake and other unique freshwater eco systems, through an integrated ecosystem approach.

Activities Covered Under NLCP

- Prevention of pollution from point sources by intercepting, diverting and treating the pollution loads entering the lake. The interception and diversion works may include sewerage & sewage treatment for the entire lake catchment area.

(i) In situ measures of lake cleaning such as de-silting, de-weeding, bioremediation, aeration, bio-manipulation, nutrient reduction, withdrawal of anoxic hypolimn ion, constructed wetland approach or any other successfully tested eco-technologies etc depending upon the site conditions.

(ii) Catchment area treatment which may include afforestation, storm water drainage, silt traps etc.

(iii) Strengthening of bund, lake fencing, shoreline development etc.

(iv) Lake front eco-development including public interface.

(v) Solid waste management2 & provision of dhobi ghats is generally not covered under NLCP.

(vi) Prevention of pollution from non-point sources by providing low cost sanitation.

(vii)Public awareness and public participation.

(viii)Capacity building, training and research in the area of Lake Conservation.

(ix) Any other activity depending upon location specific requirements

NATIONAL GANGA RIVER BASIN AUTHORITY (NGRBA)

- NGRBA was constituted on February 2009 under the Environment (Protection) Act, 1986.
- The NGRBA is a planning, financing, monitoring and coordinating body of the centre and the states.
- The objective of the NGRBA is to ensure effective abatement of pollution and conservation of the river Ganga by adopting a river basin approach for comprehensive planning and management.
- The Authority has both regulatory and developmental functions. The Authority will take measures for effective abatement of pollution and conservation of the river Ganga in keeping with sustainable development needs.

These include

- Development of a river basin management plan;
- Regulation of activities aimed at prevention, control and abatement of pollution in Ganga to maintain its water quality, and to take measures relevant to river ecology and management in the Ganga basin states;
- Maintenance of minimum ecological flows in the river Ganga;
- Measures necessary for planning, financing and execution of programmes for abatement of pollution in the river Ganga including augmentation of sewerage infrastructure, catchment area treatment, protection of flood plains, creating public awareness;
- Collection, analysis and dissemination of information relating to environmental pollution in the river Ganga;
- Investigations and research regarding problems of environmental pollution and conservation of the river Ganga;
- Promotion of water conservation practices including recycling and reuse, rain water harvesting, and decentralised sewage treatment systems;
- Monitoring and review of the implementation of various programmes or activities taken up for prevention, control and abatement of pollution in the river Ganga;
- Issue directions under section 5 of the Environment (Protection) Act, 1986 for the purpose of exercising and performing these functions and for achievement of its objectives.

WILDLIFE TRUST OF INDIA

- NGO founded: 1998
- Aim: To conserve nature, especially endangered species and threatened habitats, in partnership with communities and governments.
- The Wildlife Trust of India (WTI) is committed to the protection of India's wildlife; it achieves this by working in partnership with local communities and governments on a range of projects, from species rehabilitation to the prevention of the illegal wildlife trade.

◆◆◆◆◆◆

CHAPTER - 25

INTERNATIONAL CONVENTIONS

MAJOR ENVIRONMENT INTERNATIONAL CONVENTIONS

Nature conservation

1. United Nations Conference On Environment And Development (UNCED)
2. Convention on Biological Diversity (CBD)
3. Ramsar Convention on Wetlands
4. Convention on International Trade in Endangered Species of Fauna and Flora (CITES)
5. The Wildlife Trade Monitoring Network (TRAFFIC)
6. Convention on the Conservation of Migratory Species (CMS)
7. Coalition Against Wildlife Trafficking (CAWT)
8. International Tropical Timber Organization (ITTC)
9. United Nations Forum on Forests (UNFF)
10. International Union for Conservation of Nature and Natural Resources (IUCN)
11. Global Tiger Forum (GTF)

Hazardous material

12. Stockholm Convention
13. Basel Convention
14. Rotterdam Convention

Land

15. United Nations Convention to Combat Desertification (UNCCD)

Marine environment

16. International Whaling Commission (IWC)

Atmosphere

17. Vienna convention and Montreal Protocol
18. United Nations Framework Convention on Climate Change (UNFCCC)
19. Kyoto Protocol

1. United Nations Conference On Environment And Development (UNCED)

Also known as the Rio Summit, Rio Conference, Earth Summit held in Rio de Janeiro in June 1992.

The issues addressed included:

- Systematic scrutiny of patterns of production — particularly the production of toxic components, such as lead in gasoline, or poisonous waste including radioactive chemicals
- Alternative sources of energy to replace the use of fossil fuels which are linked to global climate change
- New reliance on public transportation systems in order to reduce vehicle emissions, congestion in cities and the health problems caused by polluted air and smog
- The growing scarcity of water

The Earth Summit resulted in the following documents:

- Rio Declaration on Environment and Development
- Agenda 21
- Forest Principles

Moreover, two important legally binding agreements

1. Convention on Biological Diversity
2. Framework Convention on Climate Change (UNFCCC).

The Rio Declaration on Environment and Development, often shortened to Rio Declaration, was a short document produced at the 1992 United Nations "Conference on Environment and Development" (UNCED), informally known as the Earth Summit. The Rio Declaration consisted of 27 principles intended to guide future sustainable development around the world.

Agenda 21

- Agenda 21 is an action plan of the United Nations (UN) related to sustainable development and was an outcome of the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, in 1992.
- It is a comprehensive blueprint of action to be taken globally, nationally and locally by organizations of the UN, governments, and major groups in every area in which humans directly affect the environment.
- The number 21 refers to an agenda for the 21st century.

Local Agenda 21

- The implementation of Agenda 21 was intended to involve action at international, national, regional and local levels. Some national and state governments have legislated or advised that local authorities take steps to implement the plan locally, as recommended in Chapter 28 of the document. Such programmes are often known as 'Local Agenda 21' or 'LA21'.

Agenda 21 for culture

- During the first World Public Meeting on Culture, held in Porto Alegre, Brazil in 2002, it came up with the idea to draw up document guidelines for local cultural policies, a document comparable to what Agenda 21 meant in 1992 for the environment.
- The Agenda 21 for culture is the first document with worldwide mission that advocates establishing the groundwork of an undertaking by cities and local governments for cultural development.

Rio+5

- In 1997, the General Assembly of the UN held a special session to appraise five years of progress on the implementation of Agenda 21 (Rio +5).
- The Assembly recognized progress as 'uneven' and identified key trends including increasing globalization, widening inequalities in income and a continued deterioration of the global environment.

The Johannesburg Summit

- The Johannesburg Plan of Implementation, agreed at the World Summit on Sustainable Development (Earth Summit 2002) affirmed UN commitment to 'full implementation' of Agenda 21, alongside achievement of the Millennium Development Goals and other international agreements.

Rio +20

- "Rio+20" is the short name for the United Nations Conference on Sustainable Development which took place in Rio de Janeiro, Brazil in June 2012 – twenty years after the landmark 1992 Earth Summit in Rio.
- At the Rio+20 Conference, world leaders, along with thousands of participants from the private sector, NGOs and other groups, came together to shape how we can reduce poverty, advance social equity and ensure environmental protection on an ever more crowded planet.
- The official discussions focussed on two main themes:

1. how to build a green economy to achieve sustainable development and lift people out of poverty; and
2. how to improve international coordination for sustainable development.

- AT Rio+20, more than $513 billion was pledged to build a sustainable future. It signaled a major step forward in achieving the future we want.

2. Convention on Biological Diversity (CBD)

- CBD is a Legally binding Convention recognized for the first time, that the conservation of biological diversity is "a common concern of humankind" and is an integral part of the development process. The agreement covers all ecosystems, species, and genetic resources.

Objectives

- The conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

Three main goals:

- The conservation of biodiversity
- Sustainable use of the components of biodiversity
- Sharing the benefits arising from the commercial and other utilization of genetic resources in a fair and equitable way

The Convention acknowledges that substantial investments are required to conserve biological diversity. It argues, however, that conservation will bring us significant environmental, economic and social benefits in return.

Cartagena Protocol on Biosafety to the Convention on Biological Diversity

Biosafety refers to the need to protect human health and the environment from the possible adverse effects of the products of modern biotechnology.

The Convention clearly recognizes these twin aspects of modern biotechnology.

1. Access to and transfer of technologies
2. Appropriate procedures to enhance the safety of biotechnology technologies.

Objective

Is to contribute to ensuring an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health, and specifically focusing on transboundary movements.

- The Cartagena Protocol on Biosafety is an additional agreement to the Convention on Biological Diversity.
- The Protocol establishes procedures for regulating the import and export of LMOs from one country to another.
- The Protocol also requires Parties to ensure that LMOs being shipped from one country to another are handled, packaged and transported in a safe manner.
- The shipments must be accompanied by documentation that clearly identifies the LMOs, specifies any requirements for the safe handling, storage, transport and use and provides contact details for further information.

There are two main sets of procedures, one for LMOs intended for direct introduction into the environment, known as the advance informed agreement (AIA) procedure, and another for LMOs intended for direct use as food or feed, or for processing (LMOs-FFP).

Advance Informed Agreement

- Under the AIA procedure, a country intending to export an LMO for intentional release into the environment must notify in writing the Party of import before the first proposed export takes place.
- The Party of import must acknowledge receipt of the notification within 90 days and must communicate its decision on whether or not to import the LMO within 270 days.
- Parties are required to ensure that their decisions are based on a risk assessment of the LMO, which must be carried out in a scientifically sound and transparent manner.
- Once a Party takes a decision on the LMO, it is required to communicate the decision as well as a summary of the risk assessment to a central information system, the Biosafety Clearing-House (BCH).

LMOs- food or feed, or for processing

- Under the procedure for LMOs-FFP, Parties that decide to approve and place such LMOs on the market are required to make their decision and relevant information, including the risk assessment reports, publicly available through the BCH.

Nagoya—Kuala Lumpur Supplementary Protocol

- The Cartagena Protocol is reinforced by the Nagoya—Kuala Lumpur Supplementary Protocol on Liability and Redress.
- The Supplementary Protocol specifies response measures to be taken in the event of damage to biodiversity resulting from LMOs.
- The competent authority in a Party to the Supplementary Protocol must require the person in control of the LMO (operator) to take the response measures or it may implement such measures itself and recover any costs incurred from the operator.

Nagoya Protocol

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the Convention on Biological Diversity is a supplementary agreement to the Convention on Biological Diversity.

It provides a transparent legal framework for the effective implementation of one of the three objectives of the CBD.

Objective

Is the fair and equitable sharing of benefits arising from the utilization of genetic resources, thereby contributing to the conservation and sustainable use of biodiversity.

Obligations

The Nagoya Protocol sets out core obligations for its contracting Parties to take measures in relation to access to genetic resources, benefit-sharing and compliance.

Access obligations

- Domestic-level access measures are to:
- Create legal certainty, clarity and transparency
- Provide fair and non-arbitrary rules and procedures
- Establish clear rules and procedures for prior informed consent and mutually agreed terms
- Provide for issuance of a permit or equivalent when access is granted
- Create conditions to promote and encourage research contributing to biodiversity conservation and sustainable use
- Pay due regard to cases of present or imminent emergencies that threaten human, animal or plant health
- Consider the importance of genetic resources for food and agriculture for food security

Benefit-sharing obligations

- Domestic-level benefit-sharing measures are to provide for the fair and equitable sharing of benefits arising from the utilization of genetic resources with the contracting party providing genetic resources.
- Utilization includes research and development on the genetic or biochemical composition of genetic resources, as well as subsequent applications and commercialization.
- Sharing is subject to mutually agreed terms.
- Benefits may be monetary or non-monetary such as royalties and the sharing of research results.

Compliance obligations

Specific obligations to support compliance with the domestic legislation or regulatory requirements of the contracting party providing genetic resources, and contractual obligations reflected in mutually agreed terms, are a significant innovation of the Nagoya Protocol. Contracting Parties are to:

- Take measures providing that genetic resources utilized within their jurisdiction have been accessed in accordance with prior informed consent, and that mutually agreed terms have been established, as required by another contracting party
- Cooperate in cases of alleged violation of another contracting party's requirements
- Encourage contractual provisions on dispute resolution in mutually agreed terms
- Ensure an opportunity is available to seek recourse under their legal systems when disputes arise from mutually agreed terms
- Take measures regarding access to justice
- Take measures to monitor the utilization of genetic resources after they leave a country including by designating effective checkpoints at any stage of the value-chain: research, development, innovation, pre-commercialization or commercialization

Traditional knowledge

- The Nagoya Protocol addresses traditional knowledge associated with genetic resources with provisions on access, benefit-sharing and compliance.
- It also addresses genetic resources where indigenous and local communities have the established right to grant access to them.
- Contracting Parties are to take measures to ensure these communities' prior informed consent, and fair and equitable benefit-sharing, keeping in mind community laws and procedures as well as customary use and exchange.

Importance

The Nagoya Protocol will create greater legal certainty and transparency for both providers and users of genetic resources by:

- Establishing more predictable conditions for access to genetic resources.
- Helping to ensure benefit-sharing when genetic resources leave the contracting party providing the genetic resources

By helping to ensure benefit-sharing, the Nagoya Protocol creates incentives to conserve and sustainably use genetic resources, and therefore enhances the contribution of biodiversity to development and human well-being.

The Biodiversity Target

- It was adopted in May 2002 during the sixth Conference of the Parties to the Convention on Biological Diversity.
- The Target aimed to achieve, by 2010 'a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth'.
- Unfortunately, we were unable to meet the target. As we are facing an ever-increasing biodiversity crisis, we need a new, clear and realistic target to respond to it.

Strategic Plan For Biodiversity 2011-2020

- In the tenth meeting of the Conference of the Parties, held in 2010, in Nagoya, Aichi Prefecture, Japan, adopted a revised and updated Strategic Plan for Biodiversity, including the Aichi Biodiversity Targets, for the 2011-2020 period.
- The tenth meeting of the Conference of the Parties agreed to translate this overarching international framework into national biodiversity strategies and action plans within two years.
- Additionally, the meeting decided that the fifth national reports, due by 31 March 2014, should focus on the implementation of the 2011-2020 Strategic Plan and progress achieved towards the Aichi Biodiversity Targets.

AICHI BIODIVERSITY TARGETS

Strategic Goal A:

Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

1. By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.
2. By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.
3. By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.
4. By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Strategic Goal B:

Reduce the direct pressures on biodiversity and promote sustainable use

5. By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.
6. By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.
7. By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.
8. By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.
9. By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.
10. By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

Strategic Goal C:

To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

11. By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.
12. By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.
13. By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Strategic Goal D:

Enhance the benefits to all from biodiversity and ecosystem services

14. By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.
15. By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.
16. By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

Strategic Goal E:

Enhance implementation through participatory planning, knowledge management and capacity building

17. By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.
18. By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.
19. By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.
20. By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

CoP 11 hyderabad

- One of the most important outcomes of the CoP is the commitment of the Parties to double the international financial flows for Bio Diversity by 2015. This will translate into additional financial flows to the developing countries to the tune of about US $ 30 billion equivalent to about Rs. 1,50,000 crore over the next 8 years.
- India has committed US $50 million towards strengthening the institutional mechanism for biodiversity conservation in the country during its presidency of the Convention on Biodiversity (CBD) called the Hyderabad Pledge
- The funds will be used to enhance technical and human capabilities at the national and state-level mechanisms to attain the CBD objectives.
- The country has also earmarked funds to promote similar capacity building in developing countries. India formally took charge of the presidency of CBD from Japan for the next two years on October 8 at the inaugural of the eleventh meeting of the Conference of Parties (CoP 11) to CBD.

- India has instituted together with UNDP Biodiversity Governance Awards. The first such awards were given during the CoP 11. It is now proposed to institute Rajiv Gandhi International Award for Harnessing Biodiversity for Livelihood.

3. RAMSAR CONVENTION ON WETLANDS

- The Convention on Wetlands [waterfowl convention] is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.
- It was adopted in the Iranian city of Ramsar in 1971 and came into force in 1975, and it is the only global environmental treaty that deals with a particular ecosystem.
- Ramsar is not affiliated with the United Nations system of Multilateral Environmental Agreements, but it works very closely with the other MEAs and is a full partner among the "biodiversity-related cluster" of treaties and agreements.
- World Wetlands Day, 2 February every year. Number of Contracting Parties: 163

Mission

"The conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world".

"Three pillars" of the Convention

The Parties have committed themselves to:

- Work towards the wise use of all their wetlands through national land-use planning, appropriate policies and legislation, management actions, and public education;
- Designate suitable wetlands for the List of Wetlands of International Importance ("Ramsar List") and ensure their effective management; and
- Cooperate internationally concerning transboundary wetlands, shared wetland systems, shared species, and development projects that may affect wetlands.

The "Ramsar List"

- At the time of joining the Convention, each Contracting Party designates at least one site for inclusion in the List of Wetlands of International Importance (the "Ramsar List").
- The addition of a site to the Ramsar List confers upon it the prestige of international recognition and expresses the government's commitment to take all steps necessary to ensure the maintenance of the ecological character of the site.

Transboundary Ramsar Sites

- An ecologically coherent wetland extends across national borders and the Ramsar site authorities on both or all sides of the border have formally agreed to collaborate in its management, and have notified the Secretariat of this intent.
- This is a cooperative management arrangement and not a distinct legal status for the Ramsar sites involved.

The Montreux Record

- Adopted by the Conference of the Contracting Parties in Brisbane, 1996, accompanying the Guidelines for Operation of the Montreux Record
- The Montreux Record is a register of wetland sites on the List of Wetlands of International Importance where changes in ecological character have occurred, are occurring, or are likely to occur as a result of technological developments, pollution or other human interference.
- It is the the principal tool of the Convention and is maintained as part of the Ramsar List.

Indian wetland and the Montreux Record

- Keoladeo National Park, Rajasthan and Loktak Lake, Manipur have been included in Montreux Record in 1990 and in 1993 respectively
- Chilika Lake, Orissa included in Montreux Record in 1993 have been removed in November 2002. It is placed on the Montreux Record due to problems caused by siltation and sedimentation which was choking the mouth of the lake; removed from the Record in 2002 following rehabilitation efforts for which the Chilika Development Authority received the Ramsar Wetland Conservation Award for 2002.

"IOPs"

Five global non-governmental organizations (NGOs) have been associated with the treaty since its beginnings and were confirmed in the formal status of International Organization Partners (IOPs) of the Convention.

1. BirdLife International (formerly ICBP)
2. IUCN – The International Union for the Conservation of Nature
3. IWMI – The International Water Management Institute
4. Wetlands International (formerly IWRB, the Asian Wetlands Bureau, and Wetlands for the Americas)
5. WWF (World Wide Fund for Nature) International

The Changwon Declaration on human well-being and wetlands

- The Changwon Declaration highlights positive action for ensuring human well-being and security in the future under the themes - water, climate change, people's livelihood and health, land use change, and biodiversity,

India and wetland convention

- India became a contracting party to the Ramsar Convention in 1981 and has been implementing conservation programmes for wetlands, mangroves and coral reefs.
- India presently has 26 sites designated as Wetlands of International Importance.
- There is close coordination between implementing units of Ramsar with that of CBD at the national level. India took a lead role in the formulation of Ramsar guidelines on integration of wetlands into river basin management.
- The National Conservation Strategy and Policy Statements on Environment and Development (1992) and National Water Policy (2002) highlight conservation and sustainable development of wetlands.

4. CITES

- In the early 1960s, international discussion began focusing on the rate at which the world's wild animals and plants were being threatened by unregulated international trade.
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments entered into force in 1975, and became the only treaty to ensure that international trade in plants and animals does not threaten their survival in the wild.
- Currently 176 countries are Parties to CITES.
- CITES is administered through the United Nations Environment Programme (UNEP). A Secretariat, located in Geneva, Switzerland, oversees the implementation of the treaty and assists with communications between countries.

Protecting Species from Unsustainable Trade

- Species for which trade is controlled are listed in one of three Appendices to CITES, each conferring a different level of regulation and requiring CITES permits or certificates.

Appendix I:

- Includes species threatened with extinction and provides the greatest level of protection, including restrictions on commercial trade. Examples include gorillas, sea turtles, most lady slipper orchids, and giant pandas.

Appendix II:

- Includes species that although currently not threatened with extinction, may become so without trade controls. It also includes species that resemble other listed species and need to be regulated in order to effectively control the trade in those other listed species.

Appendix III:

- Includes species for which a range country has asked other Parties to help in controlling international trade. Examples include map turtles, walruses and Cape stag beetles.
- Until CoP13, these meeting were held every two years; since then, CoPs are held every three years.
- CoP16 is scheduled to occur from March 3-14, 2013 in Bangkok, Thailand.

CITES Role in Conservation

- Over the last several decades, CITES has helped ensure global conservation of species.
- The Parties have adopted a 5-year strategic vision to guide CITES through 2013.

The plan sets the following goals:

- Ensure compliance with and implementation and enforcement of the Convention.
- Secure the necessary financial resources and means for the operation and implementation of the Convention.
- Contribute to significantly reducing the rate of biodiversity loss by ensuring that CITES and other multilateral instruments and processes are coherent and mutually supportive.

5. TRAFFIC: The Wildlife Trade Monitoring Network

- TRAFFIC is a joint conservation programme of WWF and IUCN.
- It was established in 1976 by the Species Survival Commission of IUCN, principally as a response to the entry into force during the previous year of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
- TRAFFIC is an international network, consisting of TRAFFIC International, based in Cambridge, UK with offices on five continents.
- Since its founding, TRAFFIC has grown to become the world's largest wildlife trade monitoring programme, and a global expert on wildlife trade issues.
- This non-governmental organization undertakes its activities in close collaboration with governments and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Secretariat.

Goal

- To ensure that trade in wild plants and animals is not a threat to the conservation of nature.

Vision

- Is of a world in which trade in wild animals and plants will be managed at sustainable levels without damaging the integrity of ecological systems and in such a manner that it makes a significant contribution to human needs, supports local and national economies and helps to motivate commitments to the conservation of wild species and their habitats.

6. Convention on the Conservation of Migratory Species (CMS)

- The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) aims to conserve terrestrial, aquatic and avian migratory species throughout their range.
- It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale.
- The Convention's has membership of 117 Parties from Africa, Central and South America, Asia, Europe and Oceania.
- The only global convention specializing in the conservation of migratory species, their habitats and migration routes, CMS complements and co-operates with a number of other international organizations, NGOs and partners in the media as well as in the corporate sector.

Appendix I

- Migratory species threatened with extinction are listed on Appendix I of the Convention.
- CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them. Besides establishing obligations for each State joining the Convention, CMS promotes concerted action among the Range States of many of these species.

Appendix II

- Migratory species that need or would significantly benefit from international co-operation are listed in Appendix II of the Convention. For this reason, the Convention encourages the Range States to conclude global or regional Agreements.

CMS as a framework Convention.

- The Agreements may range from legally binding treaties (called Agreements) to less formal instruments, such as Memoranda of Understanding, and can be adapted to the requirements of particular regions.
- The development of models tailored according to the conservation needs throughout the migratory range is a unique capacity to CMS.

7. Coalition Against Wildlife Trafficking (CAWT)

- The Coalition Against Wildlife Trafficking (CAWT) aims to focus public and political attention and resources on ending the illegal trade in wildlife and wildlife products.
- Initiated in 2005, CAWT is a unique voluntary public-private coalition of like-minded governments and organizations sharing a common purpose.

CAWT is leveraging the combined strengths of government and nongovernmental partners to:

- Improve Wildlife Law Enforcement by expanding enforcement training and information sharing and strengthening regional cooperative networks.

- Reduce consumer demand for illegally traded wildlife by raising awareness of the impacts of illegal wildlife trade on biodiversity and the environment, livelihoods, and human health; its links to organized crime; and the availability of sustainable alternatives.
- Catalyse high-level political will to fight wildlife trafficking by broadening support at the highest political levels for actions to combat the illegal trade in wildlife.

The Coalition complements and reinforces existing national, regional and international efforts, including the work of the Convention on International Trade in Endangered Species, which monitors and regulates international trade in endangered and threatened species and their derivatives.

The CAWT organisation is not directly involved in any enforcement activities.

8. The International Tropical Timber Organization (ITTO)

- ITTO is an intergovernmental organization, under UN (1986) promoting the conservation and sustainable management, use and trade of tropical forest resources. Its members represent about 80% of the world's tropical forests and 90% of the global tropical timber trade.
- Like all commodity organizations it is concerned with trade and industry, but like an environmental agreement it also pays considerable attention to the sustainable management of natural resources.
- It manages its own program of projects and other activities, enabling it to quickly test and operationalize its policy work.
- ITTO develops internationally agreed policy documents to promote sustainable forest management and forest conservation and assists tropical member countries to adapt such policies to local circumstances and to implement them in the field through projects.
- In addition, ITTO collects, analyses and disseminates data on the production and trade of tropical timber and funds a range of projects and other action aimed at developing industries at both community and industrial scales.

9. United Nations Forum on Forests (UNFF)

- The Economic and Social Council of the United Nations (ECOSOC), established the United Nations Forum on Forests (UNFF) In October 2000, a subsidiary body with the main objective to promote "the management, conservation and sustainable development of all types of forests and to strengthen long-term political commitment to this end" based on the Rio Declaration, the Forest Principles, Chapter 11 of Agenda 21 and the outcome of the Intergovernmental Panel on Forests (IPF) / Intergovernmental Forum on Forests (IFF) Processes and other key milestones of international forest policy.

The Forum has universal membership, and is composed of all Member States of the United Nations and specialized agencies.

Principal Functions

The following are the principal functions in order to achieve its objective

- To facilitate implementation of forest-related agreements and foster a common understanding on sustainable forest management;
- To provide for continued policy development and dialogue among Governments, international organizations, including major groups, as identified in Agenda 21 as well as to address forest issues and emerging areas of concern in a holistic, comprehensive and integrated manner,
- To enhance cooperation as well as policy and programme coordination on forest-related issues
- To foster international cooperation and
- To monitor, assess and report on progress of the above functions and objectives
- To strengthen political commitment to the management , conservation and sustainable development of all types of forests.
- Enhance the contribution of forests to the achievement of the internationally agreed development goals, including the Millennium Development Goals, and to the implementation of the Johannesburg Declaration on Sustainable Development and the Plan of Implementation of the World Summit on Sustainable Development, bearing in mind the Monterrey Consensus of the International Conference on Financing for Development;
- Encourage and assist countries, including those with low forest cover, to develop and implement forest conservation and rehabilitation strategies,

increase the area of forests under sustainable management and reduce forest degradation and the loss of forest cover in order to maintain and improve their forest resources with a view to enhancing the benefits of forests to meet present and future needs, in particular the needs of indigenous peoples and local communities whose livelihoods depend on forests;

- Strengthen interaction between the United Nations Forum on Forests and relevant regional and subregional forest-related mechanisms, institutions and instruments, organizations and processes, with participation of major groups, as identified in Agenda 21 and relevant stakeholders to facilitate enhanced cooperation and effective implementation of sustainable forest management, as well as to contribute to the work of the Forum

IPF/IFF Process (1995-2000)

- The Intergovernmental Panel on Forests (IPF) and the Intergovernmental Forum on Forests (IFF) represent five years of international forest policy dialogue.
- The Intergovernmental Panel on Forests (IPF), established by the Commission on Sustainable Development (CSD) for two years (1995-97) to provide a forum for forest policy deliberations.
- Subsequently, in 1997, ECOSOC established the Intergovernmental Forum on Forests (IFF), for three years (1997-2000).

Global Objectives on Forests

Member States reaffirm the following shared global objectives on forests and their commitment to work globally, regionally and nationally to achieve progress towards their achievement by 2015

The four Global Objectives seek to:

1. Reverse the loss of forest cover worldwide through sustainable forest management (SFM), including protection, restoration, afforestation and reforestation, and increase efforts to prevent forest degradation;
2. Enhance forest-based economic, social and environmental benefits, including by improving the livelihoods of forest-dependent people;
3. Increase significantly the area of sustainably managed forests, including protected forests, and increase the proportion of forest products derived from sustainably managed forests; and
4. Reverse the decline in official development assistance for sustainable forest management and mobilize significantly-increased new and additional financial resources from all sources for the implementation of SFM.

Non-Legally Binding Instrument on All Types of Forests (NLBI)

- The Seventh Session of the UNFF adopted the Non-Legally Binding Instrument on All Types of Forests on April 2007.
- It is the first time Member States have agreed to an international instrument for sustainable forest management.
- The instrument is expected to have a major impact on international cooperation and national action to reduce deforestation, prevent forest degradation, promote sustainable livelihoods and reduce poverty for all forest-dependent peoples.
- The instrument is voluntary and non-legally binding

10. IUCN

IUCN was founded in October 1948 as the International Union for the Protection of Nature (or IUPN) following an international conference in Fontainebleau, France.

The organization changed its name to the International Union for Conservation of Nature and Natural Resources in 1956 with the acronym IUCN (or UICN) with its head quarters in Gland, Switzerland.

Vision

Just world that values and conserves nature.

Missionss

To influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable.

IUCN supports scientific research, manages field projects globally and brings governments, non-government organizations, United Nations agencies, companies and local communities together to develop and implement policy

IUCN Members include both States and non-governmental organizations.

A neutral forum for governments, NGOs, scientists, business and local communities to find practical solutions to conservation and development challenges.

Priority Areas oF IUCN

- Biodiversity
- Climate change
- Sustainable energy
- Human well-being
- Green economy

11. THE GLOBAL TIGER FORUM (GTF)

The Global Tiger Forum (GTF) is an inter-governmental and international body established with members from willing countries to embark on a worldwide campaign, common approach, promotion of appropriate programmes and controls to save the remaining five sub-species of tigers in the wild distributed over 14 tiger range countries of the world.

Formed in 1994 with its secretariat at New Delhi, GTF is the only inter-governmental & international body campaigning to save the TIGER worldwide.

The General Assembly of GTF shall meet once in three years.

Goal:

To highlight the rationale for tiger preservation and provide leadership and common approach throughout the world in order to safeguard the survival of the tiger, its prey and its habitat.

Objectives:

- To promote a worldwide campaign to save the tiger, its prey and its habitat;
- To promote a legal framework in the countries involved for bio-diversity conservation;
- To increase the protected area network of habitats of the tiger and facilitate their interpassages in the range countries;
- To promote eco-development programmes with the participation of the communities living in and around protected areas;
- To urge countries to enter into relevant conventions for conservation of tiger and elimination of illegal trade;
- To promote and carry out scientific research to generate information useful for tiger, it's prey and its habitat to disseminate such information in an easily accessible manner;
- To promote the development and exchange among themselves, of appropriate technologies and training programmes for scientific wildlife management;
- To encourage range countries to prepare and implement their individual action plans for protection and growth of the tiger population and its prey base. Improvement of the habitat and common preservation programme can be taken up bilaterally by the range countries having adjoining habitats, but their implementation should be carried out separately by the respective range countries.
- To involve inter-governmental organisations in the protection of the tiger;
- To set up a participative fund of an appropriate size to engender awareness in all places where people consume tiger derivatives for eliminating such consumption of tiger products, and identifying substitutes, in the interests of conservation.

Global Tiger Initiative

An alliance of governments, international agencies, civil society, and the private sector united to save wild tigers from extinction

Goals of GTI

- To support capacity-building in governments for responding effectively to the transnational challenge of illegal trade in wildlife and for scientifically managing tiger landscapes in the face of mounting and varied threats;
- To curtail international demand for tiger parts and other wildlife that has been responsible for drastic declines in tiger populations;
- To develop mechanisms for safeguarding habitats from development through planning 'smart, green' infrastructure and sensitive industrial development;
- To create innovative and sustainable financing mechanisms for tiger landscapes including protected areas;
- To build strong local constituencies for tiger conservation through development of economic incentives and alternative livelihoods for local people;
- To spread the recognition among governments, international aid agencies and the public that tiger habitats are high-value diverse ecosystems with the potential to provide immense benefits-both tangible and intangible

12. THE STOCKHOLM CONVENTION ON POP

The Stockholm Convention on Persistent Organic Pollutants was adopted at a Conference of Plenipotentiaries on 22 May 2001 in Stockholm, Sweden and entered into force on 17 May 2004,

POPs

Persistent Organic Pollutants (POPs) are organic chemical substances, that is, they are carbon-based. They possess a particular combination of physical and chemical properties such that, once released into the environment, they:

- remain intact for exceptionally long periods of time (many years);
- become widely distributed throughout the environment as a result of natural processes involving soil, water and, most notably, air;
- accumulate in the fatty tissue of living organisms including humans, and are found at higher concentrations at higher levels in the food chain; and
- are toxic to both humans and wildlife.

In addition, POPs concentrate in living organisms through another process called bioaccumulation. Though not soluble in water, POPs are readily absorbed in fatty tissue, where concentrations can become magnified by up to 70,000 times the background levels.

The 12 initial POPs

Initially, twelve POPs have been recognized as causing adverse effects on humans and the ecosystem and these can be placed in 3 categories:

1. Pesticides: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, toxaphene;
2. Industrial chemicals: hexachlorobenzene, polychlorinated biphenyls (PCBs); and
3. By-products: hexachlorobenzene; polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/PCDF), and PCBs.

The new POPs under the Stockholm Convention

Nine new POPs

At its fourth meeting held in 2009, the CoP adopted amendments to Annexes A, B and C to the Stockholm Convention to list nine new persistent organic pollutants.

1. Pesticides: chlordecone, alpha hexachlorocyclohexane, beta hexachlorocyclohexane, lindane, pentachlorobenzene;
2. Industrial chemicals: hexabromobiphenyl, hexabromodiphenyl ether and heptabro-modiphenyl ether, pentachlorobenzene, perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride, tetrabromodiphenyl ether and pentabromodiphenyl ether; and
3. By-products: alpha hexachlorocyclohexane, beta hexachlorocyclohexane and pentachlorobenzene.

Endosulfan

At its fifth meeting held in 2011, the CoP adopted an amendment to Annex A to the Stockholm Convention to list technical endosulfan and its related isomers with a specific exemption.

13. BASEL CONVENTION

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted on 22 March 1989 by the Conference of Plenipotentiaries in Basel, Switzerland, in response to a public outcry following the discovery, in the 1980s, in Africa and other parts of the developing world of deposits of toxic wastes imported from abroad.

Objective

To protect human health and the environment against the adverse effects of hazardous wastes. Its scope of application covers a wide range of wastes defined as "hazardous wastes" based on their origin and/or composition and their characteristics, as well as two types of wastes defined as "other wastes" - household waste and incinerator ash.

Principal aims:

- The reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, wherever the place of disposal;
- the restriction of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management; and
- a regulatory system applying to cases where transboundary movements are permissible.

Waste under the Basel Convention

Wastes are substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law.

Annex

Annex I of the Convention, as further clarified in Annexes VIII and IX, lists those wastes that are classified as hazardous and subject to the control procedures under the Convention.

Annex II of the Convention identifies those wastes that require special consideration (known as "other wastes", and which primarily refer to household wastes).

Examples of wastes regulated by the Basel Convention

- Biomedical and healthcare wastes
- Used oils
- Used lead acid batteries
- Persistant Organic Pollutant wastes (POPs wastes),
- Polychlorinated Biphenyls (PCBs),
- Thousands of chemical wastes generated by industries and other consumers

14. ROTTERDAM CONVENTION

- It was adopted in 1998 by a Conference of Plenipotentiaries in Rotterdam, the Netherlands and entered into force on 24 February 2004.
- The Convention creates legally binding obligations for the implementation of the Prior Informed Consent (PIC) procedure. It built on the voluntary PIC procedure, initiated by UNEP and FAO in 1989 and ceased on 24 February 2006.
- The Convention covers pesticides and industrial chemicals that have been banned or severely restricted for health or environmental reasons by Parties and which have been notified by Parties for inclusion in the PIC procedure.

Objectives:

- to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm;
- to contribute to the environmentally sound use of those hazardous chemicals, by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties.

Annex III Chemicals

- The chemicals listed in Annex III include pesticides and industrial chemicals that have been banned or severely restricted for health or environmental reasons by two or more Parties and which the Conference of the Parties has decided to subject to the PIC procedure.
- There are a total of 43 chemicals listed in Annex III, 32 are pesticides (including 4 severely hazardous pesticide formulations) and 11 industrial chemicals.

One notification from each of two specified regions triggers consideration of addition of a chemical to Annex III of the Convention. Severely hazardous pesticide formulations that present a risk under conditions of use in developing countries or countries with economies in transition may also be proposed for inclusion in Annex III.

15. UNCCD

- Established in 1994, UNCCD is the sole legally binding international agreement linking environment and development to sustainable land management.
- The UNCCD is particularly committed to a bottom-up approach, encouraging the participation of local people in combating desertification and land degradation.
- The United Nations Convention to Combat Desertification (UNCCD) is one of the Rio Conventions that focuses on desertification, land degradation and drought (DLDD).
- 'Desertification' as defined in the UNCCD refers to land degradation in the drylands (arid, semi arid and dry sub humid regions) resulting from various factors and does not connote spread or expansion of deserts.
- UNCCD with 194 Parties is a unique instrument that recognises land degradation as an important factor affecting some of the most vulnerable people and ecosystems in the world.
- The convention aims at adaption and can, on implementation, significantly contribute to

achieving the Millennium Development Goals (MDGs), as well as sustainable development and poverty reduction by means of arresting and reversing land degradation.

- The convention promotes sustainable land management (SLM) as solution to global challenges. Land degradation is long-term loss of ecosystem function and productivity caused by disturbances from which the land cannot recover unaided. While Sustainable Land Management is focused on changes in land cover/land use in order to maintain and enhance ecosystems functions and services.

16. International Whaling Commission

- The International Whaling Commission is the global intergovernmental body charged with the conservation of whales and the management of whaling with headquarters in Cambridge, United Kingdom.
- It was set up under the International Convention for the Regulation of Whaling which was signed in Washington DC on 2nd December 1946

Preamble

To provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry.

- Main duty
- To keep under review and revise as necessary the measures laid down in the Schedule to the Convention which govern the conduct of whaling throughout the world.
- These measures, among other things, provide for the complete protection of certain species; designate specified areas as whale sanctuaries; set limits on the numbers and size of whales which may be taken; prescribe open and closed seasons and areas for whaling; and prohibit the capture of suckling calves and female whales accompanied by calves.
- The compilation of catch reports and other statistical and biological records is also required.
- In 1986 the Commission introduced zero catch limits for commercial whaling. This provision is still in place today, although the Commission continues to set catch limits for aboriginal subsistence whaling.
- As well as keeping whale catch limits under review, the Commission works to promote the recovery of depleted whale populations by addressing a range of specific issues. These include ship strikes, entanglement events, environmental concerns and establishing protocols for whale watching.

17. VIENNA CONVENTION

- Vienna convention adopted in the year 1985 and entered into force in 1988.
- It acts as a framework for the international efforts to protect the ozone layer however it does not include legally binding reduction goals for the use of CFCs.
- The Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol on Substances that Deplete the Ozone Layer are dedicated to the protection of the earth's ozone layer. With 197 parties, they are the most widely ratified treaties in United Nations history.

Montreal Protocol

- The Montreal Protocol on Substances that Deplete the Ozone Layer was designed to reduce the production and consumption of ozone depleting substances in order to reduce their abundance in the atmosphere, and thereby protect the earth's fragile ozone Layer.
- The treaty was opened for signature on September 16, 1987, and entered into force on January 1, 1989, followed by a first meeting in Helsinki, May 1989. Since then, it has undergone seven revisions, in 1990 (London), 1991 (Nairobi), 1992 (Copenhagen), 1993 (Bangkok), 1995 (Vienna), 1997 (Montreal), and 1999 (Beijing).

India and Protection of Ozone Layer

- India became a Party to the Vienna Convention for the Protection of Ozone Layer on 19 June 1991 and the Montreal Protocol on substances that deplete the ozone layer on 17 September 1992.
- Consequently, it ratified the Copenhagen, Montreal and Beijing Amendments in 2003.
- India produces CFC-11, CFC-12, CFC-113, Halon-1211, HCFC-22, Halon-1301, Carbontetrachloride (CTC), methyl chloroform and methyl bromide. These ozone Depleting Substances (ODS) are used in refrigeration and air conditioning, fire fighting, electronics, foams,aerosol fumigation applications.
- A detailed India Country Programme for phase out of ODS was prepared in 1993 to ensure the

phase out of ODS according to the national industrial development strategy, without undue burden to the consumers and the industry and for accessing the Protocol's Financial Mechanism in accordance with the requirements stipulated in the Montreal Protocol.

- The Ministry of Environment and Forests established an Ozone Cell and a steering committee on the Montreal Protocol to facilitate implementation of the India Country Programme for phasing out ODS (ozone depleting substances) production by 2010.
- In order to meet the objectives of the Protocol, the Indian government has granted full exemption from payment of Customs and Central Excise Duties on import of goods designed exclusively for non-ODS technology.
- India has also been facilitating implementation of the Montreal Protocol in South and South East Asia and the Pacific regions.

18. GLOBALLY IMPORTANT AGRICULTURAL HERITAGE SYSTEMS

The FAO recognizes the agricultural heritage regions of the world under a programme titled Globally Important Agricultural Heritage Systems (GIAHS). The purpose of GIAHS is to recognize "Remarkable land use systems and landscapes which are rich in globally significant biological diversity evolving from the co-adaptation of a community with its environment and its needs and aspirations for sustainable development".

In our country so far the following sites have received recognition under this programme:

1. Traditional Agricultural System, Koraput, Odisha
2. Below Sea Level Farming System, Kuttanad, Kerala

In the Koraput system, women have played a key role in the conservation of biodiversity. The Kuttanad system was developed by farmers over 150 years ago to ensure their food security by learning to cultivate rice and other crops below sea level. The Kuttanad System is now attracting worldwide attention since one of the effects of global warming is sea level rise. It has therefore been an act of vision on the part of Kerala government to have decided to set up an International Research and Training Centre for Below Sea Level Farming in Kuttanad.

◆◆◆◆◆◆

CHAPTER - 26

ENVIRONMENT ISSUES AND HEALTH EFFECTS

TOXICOLOGY EFFECTS

Eco-toxicology is "a study of the effects of released pollutants on the environment and on the biota that inhabit it.

Rem

It gives an indication of biological damage. It is an estimate of the amount of radiation of any type which produces the same biological injury in man as that resulting from the absorption of a given amount of X-ray radiation or gamma radiation.

Iodine - 131

Iodine - 131 produced by nuclear tests is passed to vegetation and then appears in milk of the cattle that consume the contaminated vegetation and is passed to humans. Iodine-131 causes serious damage to thyroid gland, especially among children.

About 99% of long-term radioactivity from either strontium or radium taken into the human body is found in the bones.

Lead

Lead is highly toxic to plants and animals including man. Lead generally affects children more severely than adults. Lead poisoning causes a variety of symptoms. These include liver and kidney damage, reduction in hemoglobin formulation, mental retardation and abnormality in fertility and pregnancy. Symptoms of chronic lead-poisoning are of three general types.

a. Gastrointestinal troubles - most common in industrial workers includes intestinal stress.

b. Neuromuscular effects - collectively called lead palsy, and impairment of muscle metabolism resulting into residual paralysis and muscular atrophy.

c. Central nervous system effects - CNS syndrome - a panoply of nervous system disorders, they may lead to delirium, convulsions coma and death.

Mercury

This is the most common and most toxic in water bodies. It occurs in water as monomethyl mercury. Most industrial effluents have mercury. Methyl mercury vapours cause fatal poisoning.

High levels of mercury in fish stocks have been found, mainly in coastal areas. Mumbai, Kolkata, Karwar (in Karnataka) and North Koel (in Bihar) are some of the severely affected areas.

The recent popularity of energy efficient compact to fluorescent lamps or CFLs has added another dimension to the controversy.

Toxicity of mercury is much greater than any other substance, about 1000 times more potent than colchicines.

Fluorine

It occurs in nature as fluoride, in air, soil and water. Fluorisis is a common problem in several states of the country due to intake of high fluoride content water. Fluorides cause dental fluorisis, stiffness of joints (particularly spinal cord) causing humped back. Pain in bones and joint and outward bending of legs from the knees is called Knock-Knee syndrome. In cattle, fluoride intake causes staining, mottling and abrasion of teeth, lameness and decrease in milk production.

DDT

Toxic pesticides as BHC, PCB, DDT etc., are not easily degraded and are long-lasting in the environment. Their concentration therefore goes on increasing in water and soil with successive applications.

DDT was sprayed for many years on marshes to control mosquitoes.

The DDT has bio-magnified from water to fish eating birds and humans. DDT is known to depress the activity of estrogen, the female sex hormone and testosterone, male sex hormone. Fish die due to eating of DDT-killed insects; turtles die because of eating DDT-killed fish and so on. DDT deposited in butter fat of milk is a potential danger to infants.

The end result of DDT use is that whole population of predatory birds such as the fist hawk (osprey) and of detritus feeders as fiddler crab are wiped out. Birds are more vulnerable as DDT interferes with egg shell formation by causing a breakdown in steroid hormones which results in fragile eggs that break before the young can hatch.

LEAD IN PAINTS

- Modern houses are full of harmful chemicals. One of them is lead, present in paints.
- Though several countries have banned the use of this substance India is yet to do so, which is why paint makers use them.
- Inhaling lead dust like opening or closing windows is the most common source of lead poisoning.
- The human body is not designed to process lead. Young children are particularly vulnerable to lead as it can damage the central nervous system and the brain.
- If lead is so poisonous why do paint makers continue to use it? Using lead susbtitutes increases the cost and also reduces paint performance.

TRANSFAT

- Transfats are formed during the process of addition of hydrogen atoms to oils, a process which industry prefers as it keeps the oil from turning rancid and ensures a longer shelf life. (E.g trans-fatty acid in vanaspati).
- Transfats are associated with a host of serious health problems ranging from diabetes to heart disease to cancer.
- The health ministry in 2008 came out with a notification for labelling food including trans fats.
- Junk food high in transfats, salt and sugar, junk food gives no nutrition. In fact, getting addicted to it is making the young vulnerable to hypertension, heart diseases, diabetes and obesity.

HIGH CAFFEIENE IN ENERGY DRINKS

- Energy drinks are in controversy because of its high caffeine content. Most of these brands have upto 320 ppm of caffeine in them. These drinks are marketed as an instant source of energy.
- The manufacturers claim that it is the combination of caffeine, taurine, glucoronolactone, vitamins, herbal supplements, and sugar or sweeteners that gives the energy.
- According to study reports, it is the sugar that gives the energy rush, the caffeine only gives a 'feeling' of energy.
- Energy drinks fall under the category of 'Proprietary foods' in the Prevention of Food Adulteration (PFA) Act of 1954.
- An amendment in the PFA act 2009 ensured that caffeine in energy drinks should be capped at 145 ppm, the limit that was set for carbonated beverages.
- However, Red Bull managed to get a stay order on the amendment of the PFA act in 2010 and since then the energy drink market is expanding unregulated.
- The Food Safety and Standards Authority of India (FSSAI) is currently making regulations on energy drinks.

PESTICIDE IN HUMAN BLOOD

- Pesticides are commonly used in India but this comes at great cost to human health. It found that 15 different pesticides in the 20 blood samples tested from four villages in Punjab.

TESTING OF PESTICIDE TOXICITY

- All pesticides are tested to establish toxicity — a dose necessary to produce a measurable harmful effect, it is usually established through tests on mice, rats, rabbits and dogs.
- Results are then extrapolated on humans, and safe exposure levels predicted.
- The value commonly used to measure acute toxicity is LD 50 (a lethal dose in the short term; the subscript 50 indicates the dose is toxic enough to kill 50 per cent of lab animals exposed to the chemical). LD 50 values are measured zero onwards; the lower the LD 50 the more acutely toxic the pesticide.
- To illustrate, comparison of DDT — most used in India up to the early 1990s — with monocrotophos, currently most used.

- DDT' S LD 50 is 113 mg/kg; monocrotophos, 14 mg/kg. But never forget that lower LD 50 means higher acute toxicity.
- Pesticides once ingested, accumulate in the body fat or pass through. Organochlorine pesticides, for instance, accumulate in body fat and blood lipids. These fat-soluble chemicals persist in the body for many years.

DISEASES CAUSED BY ENVIRONMENTAL DEGRADATION

a) Minamata disease

- Minamata disease was first discovered in Minamata city in Kumamoto prefecture, Japan in 1956.
- It was caused by the release of methyl mercury in the industrial wastewater from the Chisso Corporation's chemical factory, which continued from 1932 to 1968.
- It is also referred to as Chisso-Minamata disease, is a neurological syndrome caused by severe mercury poisoning.
- Symptoms include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision and damage to hearing and speech. In extreme cases, insanity, paralysis, coma, and death follow within weeks of the onset of symptoms. A congenital form of the disease can also affect fetuses in the womb.
- This highly toxic chemical bioaccumulated in shellfish and fish in Minamata Bay and the Shiranui Sea, which when eaten by the local populace resulted in mercury poisoning. While cat, dog, pig, and human deaths continued over more than 30 years, the government and company did little to prevent the pollution.

b) Yokkaichi asthma

- Disease occurred in the city of Yokkaichi in Mie Prefecture, Japan between 1960 and 1972.
- The burning of petroleum and crude oil released large quantities of sulfur oxide, that caused severe smog, resulting in severe cases of chronic obstructive pulmonary disease, chronic bronchitis, pulmonary emphysema, and bronchial asthma among the local inhabitants.

c) Itai-itai disease

- Itai-itai disease was the documented case of mass cadmium poisoning in Toyama Prefecture, Japan, starting around 1912.
- The cadmium poisoning caused softening of the bones and kidney failure.
- The cadmium was released into rivers by mining companies in the mountains. The mining companies were successfully sued for the damage

d) Blue baby syndrome

- It is believed to be caused by high nitrate contamination in ground water resulting in decreased oxygen carrying capacity of hemoglobin in babies leading to death.
- The groundwater is thought to be contaminated by leaching of nitrate generated from fertilizer used in agricultural lands and waste dumps.
- It may also be related to some pesticides (DDT, PCBs etc), which cause eco toxicological problems in the food chains of living organisms, increasing BOD, which kills aquatic animals.

e) Pneumoconiosis

- The coal miners are frequently caught by the black lung disease, which is also called as Pneumoconiosis
- Pneumoconiosis is caused due to the deposit of coal dust in the lungs of coal miners, leads to a serious lung disease called as Black Lung disease.

f) Asbestosis

- Workers working in the asbestos industry are caught by the serious lung disease called as asbestosis.

G) Silicosis

- It is caused due to the deposit of silica in the lungs of workers working in silica industries or at the sand blasting sites

h) Emphysema

- The breaking down of sensitive tissue of lungs due to air pollution and smoke of cigarette is called as Emphysema. Once this disease happens, the lungs cannot expand and contract properly

I) Sick Building Syndrome (SBS)

- Sick building syndrome (SBS) is a combination of ailments (a syndrome) associated with an individual's place of work or residence.
- Most of the sick building syndrome is related to poor indoor air quality.

- Sick building causes are frequently pinned down to flaws in the heating, ventilation, and air conditioning (HVAC) systems. Other causes have been attributed to contaminants produced by out gassing of some types of building materials, volatile organic compounds (VOC), molds, improper exhaust ventilation of ozone, light industrial chemicals used within, or lack of adequate fresh-air intake air filtration

MISCELLANEOUS TOPICS

CHIPKO MOVEMENT

- It is a social-ecological movement that practised the Gandhian methods of satyagraha and non-violent resistance, through the act of hugging trees to protect them from falling.
- The modern Chipko movement started in the early 1970s in the Garhwal Himalayas of Uttarakhand, with growing awareness towards rapid deforestation.
- The landmark event in this struggle took place on March 26, 1974, when a group of peasant women in Reni village, Hemwalghati, in Chamoli district, Uttarakhand, India, acted to prevent the cutting of trees and reclaim their traditional forest rights that were threatened by the contractor system of the state Forest Department.
- Their actions inspired hundreds of such actions at the grassroots level throughout the region.
- By the 1980s the movement had spread throughout India and led to formulation of people-sensitive forest policies, which put a stop to the open felling of trees in regions as far reaching as Vindhyas and the Western Ghats.
- The first recorded event of Chipko however, took place in village Khejarli, Jodhpur district, in 1730 AD, when 363 Bishnois, led by Amrita Devi sacrificed their lives while protecting green Khejri trees, considered sacred by the community, by hugging them, and braved the axes of loggers sent by the local ruler, today it is seen an inspiration and a precursor for Chipko movement of Garhwal.

APPIKO MOVEMENT

- Appiko movement was a revolutionary movement based on environmental conservation in India.
- The Chipko movement in Uttarakhand in the Himalayas inspired the villagers of the district of Karnataka province in southern India to launch a similar movement to save their forests.
- In September 1983, men, women and children of Salkani "hugged the trees" in Kalase forest. (The local term for "hugging" in Kannada is appiko.)
- Appiko movement gave birth to a new awareness all over southern India.

International Standards and Environment

- The ISO 14000 environmental management standards exist to help organizations
  - a. Minimize how their operations (processes etc.) negatively affect the environment (i.e. cause adverse changes to air, water, or land)
  - b. Comply with applicable laws, regulations, and other environmentally oriented requirements,
  - c. Continually improve in the above.
- ISO 14000 is similar to ISO 9000 quality management in that both pertain to the process of how a product is produced, rather than to the product itself.
- As with ISO 9000, certification is performed by third-party organizations rather than being awarded by ISO directly.
- The ISO 19011 audit standard applies when auditing for both 9000 and 14000 compliance at once.
- List of ISO 14000 series standards
  - i. ISO 14001 Environmental management systems—Requirements with guidance for use
  - ii. ISO 14004 Environmental management systems—General guidelines on principles, systems and support techniques
  - iii. ISO 14015 Environmental assessment of sites and organizations
  - iv. ISO 14020 series (14020 to 14025) Environmental labels and declarations
  - v. ISO 14030 discusses post production environmental assessment
  - vi. ISO 14031 Environmental performance evaluation—Guidelines

vii. ISO 14040 series (14040 to 14049), Life Cycle Assessment, LCA, discusses pre-production planning and environment goal setting.

viii. ISO 14050 terms and definitions.

ix. ISO 14062 discusses making improvements to environmental impact goals.

x. ISO 14063 Environmental communication —Guidelines and examples

xi. ISO 14064 Measuring, quantifying, and reducing Greenhouse Gas emissions.

xii. ISO 19011 which specifies one audit protocol

The National Wastelands Development Board (NWDB)

- The National Wastelands Development Board (NWDB) was set up under the Ministry of Environment & Forests in 1985 with the objective of

i. to increase tree and other green cover on wastelands,

ii. to prevent good land from becoming wasteland, and

iii. to formulate within the overall nodal policy, perspective plans and programmes for the management and development of the wastelands in the country.

- In 1992, the Board was transferred to the Ministry of Rural Development, putting under a New Department of Wastelands Development under the charge of a Minister of State.

Bioassay

- Bioassay is a test in which organisms are used to detect the presence or the effects of any other physical factor, chemical factor, or any other type of ecological disturbance.
- Bioassays are very common in pollution studies. Bioassays can be conducted by using any type of organisms. However, the fish and insect bioassays are very common.
- The aim is to find out either lethal concentration or effective concentration causing mortality or other effects.
- Ultimately they are to be used for determination of safe concentration of a chemical or maximum acceptable toxicant concentration (MATC).
- The organism is exposed to different concentrations of a toxicant for a definite period and mortality, behavioral change or other signals of distress are noted periodically.
- Out of three types, static bioassay test is designed, where the organisms are exposed to the same toxicant solution for the whole experimental period. The other two are, renewal bioassay and flow-through bioassays.

Flagship species

- A flagship species is a species chosen to represent an environmental cause, such as an ecosystem in need of conservation. These species are chosen for their vulnerability, attractiveness or distinctiveness in order to engender support and acknowledgement from the public at large. Thus, the concept of a flagship species holds that, by giving publicity to a few key species, the support given to those species will successfully leverage conservation of entire ecosystems are all species contained therein.
- Example: Indian tiger, African elephant, giant panda of China, mountain gorilla of Central Africa, orangutan of Southeast Asia and the leatherback sea turtle.

Keystone species

- Keystone species is a species whose addition to or loss from an ecosystem leads to major changes in abundance or occurrence of at least one other species. Certain species in an ecosystem is considered more important in determining the presence of many other species in that ecosystem.
- All top predators (Tiger, Lion, Crocodile, Elephant) are considered as keystone species because it regulates all other animals' population indirectly. Hence top predators are given much consideration in conservation.
- Key stone species deserves special attention from the conservation point of view. Conservation of keystone species encourages conservation of all other relevant species associated with this.
- If keystone species is lost, it will result in the degradation of whole ecosystem. For example certain plant species (ebony tree, Indian-laurel) exclusively depends upon bats for its pollination. If the bat population is reduced then regeneration of particular plants becomes more difficult. This changes the vegetation structure which adversely influence on the dependant animals.

Indicator species

- Indicator species is a species whose presence indicates the presence of a set of other species and whose absence indicates the lack of that entire set of species.
- An indicator species is any biological species that defines a trait or characteristic of the environment. For example, a species may delineate an ecoregion or indicate an environmental condition such as a disease outbreak, pollution, species competition or climate change. Indicator species can be among the most sensitive species in a region, and sometimes act as an early warning to monitoring biologists.
- Many indicator species of the ocean systems are fish, invertebrates, periphyton, macrophytes and specific species of ocean birds (like the Atlantic Puffin). Amphibian indicates chemicals, global warming and air pollution. Lichens are indicators of air quality and are sensitive to sulfur dioxide.

Foundation species

- Foundation species is a dominant primary producer in an ecosystem both in terms of abundance and influence. Example: kelp in kelp forests and corals in coral reefs.

Charismatic megafauna

- These are large animal species with widespread popular appeal that environmental activists use to achieve conservation goals well beyond just those species. Examples include the Giant Panda, the Bengal Tiger, and the Blue Whale.

Umbrella species

- Umbrella species is a wide-ranging species whose requirements include those of many other species. The protection of umbrella species automatically extends protection to other species. These are species selected for making conservation related decisions, typically because protecting these species indirectly protects the many other species that make up the ecological community of its habitat.

◆◆◆◆◆◆

GLOSSARY

- **Warm-blooded** is a term to describe animal species which have a relatively higher blood temperature, and maintain thermal homeostasis primarily through internal metabolic processes. Examples: Mammals and birds.
- **Cold-blooded** is a term often used to refer to animals that do not use their metabolism to maintain body temperature. Examples: reptiles, insects, arachnids, amphibians and fish
- **Aestivation** is a state of animal dormancy, characterized by inactivity and a lowered metabolic rate that is entered in response to high temperatures and arid conditions. It takes place during times of heat and dryness, the hot dry season, which is often but not necessarily the summer months. Invertebrate and vertebrate animals are known to enter this state to avoid damage from high temperatures and the risk of desiccation. Both terrestrial and aquatic animals undergo aestivation.
- **Hibernation** is a state of inactivity and metabolic depression in animals, characterized by lower body temperature, slower breathing, and lower metabolic rate. Hibernating animals conserve food, especially during winter when food supplies are limited, tapping energy reserves, body fat, at a slow rate. It is the animal's slowed metabolic rate which leads to a reduction in body temperature and not the other way around.
- **Reforestation** Is the restocking of existing forests and woodlands which have been depleted
- **Afforestation** is the establishment of a forest or stand of trees in an area where there was no forest
- **Deforestation** Is the removal of a forest or stand of trees where the land is thereafter converted to a non forest use
- **Agroforestry** Is an integrated approach of using the interactive benefits from combining trees and shrubs with crops and livestock. It combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy and sustainable land-use systems.
- **Habitat fragmentation** is the emergence of discontinuities (fragmentation) in an organism's preferred environment (habitat), causing population fragmentation.
- **Habitat destruction** - The process in which natural habitat is rendered functionally unable to support the species present. In this process, the organisms which previously used the site are displaced or destroyed, reducing biodiversity
- **Habitat conservation** is a land management practice that seeks to conserve, protect and restore, habitat areas for wild plants and animals, especially conservation reliant species, and prevent their extinction, fragmentation or reduction in range
- **Oligotrophic Lake** is a lake with low primary productivity, the result of low nutrient content. These lakes have low algal production, and consequently, often have very clear waters, with high drinking-water quality
- **Eutrophic lake** is a lake has high primary productivity due to excessive nutrients and is subject to algal blooms resulting in poor water quality.The bottom waters of such bodies are commonly deficient in oxygen, ranging from hypoxic to anoxic.
- **Mesotrophic lakes** is a lake with an intermediate level of productivity, greater than oligotrophic lakes, but less than eutrophic lakes. These lakes are commonly clear water lakes and ponds with beds of submerged aquatic plants and medium levels of nutrients
- **Mull soil** is one characterised by large soil animals (especially plentiful earthworms), incorporation of organic matter through the topsoil and active bacterial decomposition.
- **Mor soil** is on the other hand characterised by smaller soil animals, the buildup of a litter layer on top and decomposition mainly led by fungi
- **Calcifuge** is a plant that does not tolerate alkaline soil.
- **Calcicole or Calciphyte** is a plant that does not tolerate acidic soil.
- **Ecotopes** are the smallest ecologically-distinct landscape features in a landscape mapping and classification system. As such, they represent relatively homogeneous, spatially-explicit

landscape functional units that are useful for stratifying landscapes into ecologically distinct features for the measurement and mapping of landscape structure, function and change.

- **Ecozones** delineate large areas of the Earth's surface within which organisms have been evolving in relative isolation over long periods of time, separated from one another by geographic features, such as oceans, broad deserts, or high mountain ranges, that constitute barriers to migration
- **Productivity** or production refers to the rate of generation of biomass in an ecosystem.
- **Photoheterotrophs** are heterotrophic organisms that use light for energy, but cannot use carbon dioxide as their sole carbon source. Consequently, they use organic compounds from the environment to satisfy their carbon requirements. They use compounds such as carbohydrates, fatty acids and alcohols as their organic food
- **Chemotrophs** are organisms that obtain energy by the oxidation of electron donors in their environments
- **Phototrophs** are the organisms (usually plants) that carry out photosynthesis to acquire energy. They use the energy from sunlight to convert carbon dioxide and water into organic materials to be utilized in cellular functions such as biosynthesis and respiration.
- **Hemotrophs** are organisms that obtain energy by the oxidation of electron donors in their environments
- **Lithotroph** is an organism that uses an inorganic substrate to obtain reducing equivalents for use in biosynthesis or energy conservation via aerobic or anaerobic respiration
- **Lithophiles** are micro-organisms that can live within the pore interstices of sedimentary and even igneous rocks to depths of several kilometers.
- **Organotroph** is an organism that obtains hydrogen or electrons from organic substrates
- **Mixotroph** is a microorganism that can use a mix of different sources of energy and carbon.
- **Photic zone** or Euphotic zone is the depth of the water in a lake or ocean that is exposed to sufficient sunlight for photosynthesis to occur.
- **Biological pump** is the sum of a suite of biologically-mediated processes that transport carbon from the surface euphotic zone to the ocean's interior.
- **Standing crop** is the quantity or total weight or energy content of the organisms which are in a particular location at a particular time.
- **Endolith** is an organism that lives inside rock, coral, animal shells, or in the pores between mineral grains of a rock.
- **Detritivores** are heterotrophs that obtain nutrients by consuming detritus (decomposing organic matter). By doing so, they contribute to decomposition and the nutrient cycles. They should be distinguished from other decomposers, such as many species of bacteria, fungi and protists, unable to ingest discrete lumps of matter, instead live by absorbing and metabolising on a molecular scale. However, the terms detritivore and decomposer are often used interchangeably
- **Carrying capacity** of a biological species in an environment is the maximum population size of the species that the environment can sustain indefinitely, given the food, habitat, water and other necessities available in the environment
- **Brackish water** is water that has more salinity than fresh water, but not as much as seawater. It may result from mixing of seawater with fresh water.
- **Gene pool** is the complete set of unique alleles in a species or population
- **Genetic erosion** is a process whereby an already limited gene pool of an endangered species of plant or animal diminishes even more when individuals from the surviving population die off without getting a chance to meet and breed with others in their endangered low population.
- **Bioterrorism** is terrorism involving the intentional release or dissemination of biological agents. These agents are (bacteria, viruses, or toxins), and may be in a naturally occurring or a human-modified form.
- **Bioleaching** is the extraction of specific metals from their ores through the use of living organisms. This is much cleaner than the traditional heap leaching using cyanide. Bioleaching is one of several applications within bio hydrometallurgy and several methods are used to recover copper, zinc, lead, arsenic, antimony, nickel, molybdenum, gold, silver, and cobalt.

- **Biochemical oxygen demand** or B.O.D. is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period..
- **Microclimate** is a local atmospheric zone where the climate differs from the surrounding area. The term may refer to areas as small as a few square feet or as large as many square miles.
- **Biopiracy** is the theft of genetic materials especially plants and other biological materials by the patent process. Biopiracy is a situation where indigenous knowledge of nature, originating with indigenous people, is exploited for commercial gain without permission from and with no compensation to the indigenous people themselves.
- **BioWeb** is the connotation for a network of web-enabled biological devices (e.g. trees, plants, and flowers) which extends an internet of things to the Internet of Living Things of natural sensory devices. The BioWeb devices give insights to real-time ecological data and feedback to changes in the environment
- **Biomass** is the amount of living or organic matter present in an organism. Biomass pyramids show how much biomass is present in the organisms at each tropic level, while productivity pyramids show the production or turnover in biomass.
- **Ecological footprint** is a measure of human demand on the Earth's ecosystems. It is a standardized measure of demand for natural capital that may be contrasted with the planet's ecological capacity to regenerate
- **Algal bloom** is a rapid increase or accumulation in the population of algae in an aquatic system. Algal blooms may occur in freshwater as well as marine environments.
- **Carbon footprint** is a measurement of all greenhouse gases we individually produce and has units of tonnes (or kg) of carbon dioxide equivalent. A carbon footprint is made up of the sum of two parts, the primary footprint and the secondary footprint.
- **The primary footprint** is a measure of our direct emissions of CO_2 from the burning of fossil fuels including domestic energy consumption and transportation (e.g. car and plane). We have direct control of these.
- **The secondary footprint** is a measure of the indirect CO_2 emissions from the whole lifecycle of products we use - those associated with their manufacture and eventual breakdown. To put it very simply – the more we buy the more emissions will be caused on our behalf.
- **Carbon diet** refers to reducing the impact on climate change by reducing greenhouse gas (principally CO_2) production, without lowering their standard of living
- **Greenhouse debt** or carbon debt is the measure to which an individual person, incorporated association, business enterprise, government instrumentality or geographic community exceeds its permitted greenhouse footprint and contributes greenhouse gases that contribute to global warming and climate change
- **Biocapacity** is the capacity of an area to provide resources and absorb wastes. When the area's ecological footprint exceeds its biocapacity, unsustainability occurs.
- **Global hectare** is a measurement of biocapacity of the entire earth - one global hectare is a measurement of the average biocapacity of all hectare measurements of any biologically productive areas on the planet.
- **Carbon credit** and carbon markets are a component of national and international attempts to mitigate the growth in concentrations of greenhouse gases (GHGs). One carbon credit is equal to one metric tonne of carbon dioxide, or in some markets, carbon dioxide equivalent gases. Carbon trading is an application of an emissions trading approach.
- **Oil spill** is a release of a liquid petroleum hydrocarbon into the environment due to human activity, and is a form of pollution. The term often refers to marine oil spills, where oil is released into the ocean or coastal waters
- **Green conventions** or green meetings are conventions which are conducted in ways which minimize the environmental burdens imposed by such activities. Green event planners apply environmentally preferred practices to waste management, resource and energy use, travel and local transportation, facilities selection, siting and construction, food provision and disposal, hotels and accommodations, and management and purchasing decisions.

- **Gene banks** help preserve genetic material, be it plant or animal. In plants, this could be by freezing cuts from the plant, or stocking the seeds. In animals, this is the freezing of sperm and eggs in zoological freezers until further need.
- **Biobank** is a cryogenic storage facility used to archive biological samples for use in research and experiments
- **Xerosere** is a plant succession which is limited by water availability. It includes the different stages in a xerarch succession. Xerarch succession of ecological communities originated in extremely dry situation such as sand deserts, sand dunes, salt deserts, rock deserts etc
- **Earth Hour** is a global event organized by WWF and is held on the last Saturday of March annually, asking households and businesses to turn off their non-essential lights and other electrical appliances for one hour to raise awareness towards the need to take action on climate change.
- **Bioprospecting** is an umbrella term describing the discovery of new and useful biological samples and mechanisms, typically in less-developed countries, either with or without the help of indigenous knowledge, and with or without compensation. In this way, bioprospecting includes biopiracy and also includes the search for previously unknown compounds in organisms that have never been used in traditional medicine.
- **Poaching** is the illegal taking of wild plants or animals contrary to local and international conservation and wildlife management laws. Violations of hunting laws and regulations are normally punishable by law and, collectively, such violations are known as poaching.
- **Hunting** is the practice of pursuing any living thing, usually wildlife, for food, recreation, or trade. In present-day use, the term refers to lawful hunting, as distinguished from poaching, which is the killing, trapping or capture of the hunted species contrary to applicable law.
- **Wildlife** includes all non-domesticated plants, animals and other organisms. Domesticating wild plant and animal species for human benefit has occurred many times all over the planet, and has a major impact on the environment, both positive and negative.
- **Wildcrafting** is the practice of harvesting plants from their natural, or "wild" habitat, for food or medicinal purposes. It applies to uncultivated plants wherever they may be found, and is not necessarily limited to wilderness areas. Ethical considerations are often involved, such as protecting endangered species.
- **Conservation biology** is the scientific study of the nature and status of Earth's biodiversity with the aim of protecting species, their habitats, and ecosystems from excessive rates of extinction.
- **Extinction** is the end of an organism or of a group of organisms (taxon), normally a species.
- **Holocene extinction** refers to the extinction of species during the present Holocene epoch (since around 10,000 BC
- **Wildlife corridor** or Green corridor is an area of habitat connecting wildlife populations separated by human activities (such as roads, development, or logging). This allows an exchange of individuals between populations, which may help prevent the negative effects of inbreeding and reduced genetic diversity (via genetic drift) that often occur within isolated populations.
- **Biolink zones** are a land use category developed for biodiversity conservation and landscape adaptation under changing climates
- **Zero-emissions vehicle**, or ZEV, is a vehicle that emits no tailpipe pollutants from the onboard source of power.
- **Ocean de-oxygenation** is a term that has been suggested to describe the expansion of oxygen minimum zones in the world's oceans as a consequence of anthropogenic emissions of carbon dioxide. Oceanographers and others have discussed what phrase best describes the phenomenon to non-specialists.
- **Plasticulture** refers to the practice of using plastic materials in agricultural applications. The plastic materials themselves are often and broadly referred to as "ag plastics." Plasticulture ag plastics include soil fumigation film, irrigation drip tape/tubing, nursery pots and silage bags, but the term is most often used to describe all kinds of plastic plant/soil coverings. Such coverings range fromplastic mulch film, row coverings, high and low tunnels, to plastic greenhouses.

- **Nanotoxicology** is the study of the toxicity of nanomaterials. Because of quantum size effects and large surface area to volume ratio, nanomaterials have unique properties compared with their larger counterparts.

CLIMATE CHANGE -

- **"Climate change"** means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.
- **"Greenhouse gases"** means those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation.
- **"Source"** means any process or activity which releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas into the atmosphere.
- **"Reservoir"** means a component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored.
- **"Sink"** means any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere.

Adaptation

- Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Adaptation Fund

- The Adaptation Fund was established to finance concrete adaptation projects and programmes in developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change.
- The Adaptation Fund is financed from the share of proceeds on the clean development mechanism project activities and other sources of funding. The share of proceeds amounts to 2% of certified emission reductions (CERs) issued for a CDM project activity.
- The Adaptation Fund is supervised and managed by the Adaptation Fund Board (AFB). The AFB is composed of 16 members and 16 alternates and meets at least twice a year.
- Upon invitation from Parties, the Global Environment Facility (GEF) provides secretariat services to the AFB and the World Bank serves as trustee of the Adaptation Fund, both on an interim basis.

Adaptation Committee

- As part of the Cancun Adaptation Framework, Parties established the Adaptation Committee to promote the implementation of enhanced action on adaptation in a coherent manner under the Convention through the following functions:

I. Providing technical support and guidance to the Parties

II. Sharing of relevant information, knowledge, experience and good practices

III. Promoting synergy and strengthening engagement with national, regional and international organizations, centres and networks

IV. Providing information and recommendations, drawing on adaptation good practices, for consideration by the COP when providing guidance on means to incentivize the implementation of adaptation actions, including finance, technology and capacity-building

V. Considering information communicated by Parties on their monitoring and review of adaptation actions, support provided and received

Alliance of Small Island States (AOSIS)

- An ad hoc coalition of low-lying and island countries.
- These nations are particularly vulnerable to rising sea levels and share common positions on climate change.
- The 43 members and observers are American Samoa, Antigua and Barbuda, Bahamas, Barbados, Belize, Cape Verde, Comoros, Cook Islands, Cuba, Dominica, Dominican Republic, Federated States of Micronesia, Fiji, Grenada, Guam, Guinea-Bissau, Guyana, Haiti, Jamaica, Kiribati, Maldives, Marshall Islands, Mauritius, Nauru, Netherlands Antilles, Niue, Palau, Papua New Guinea, Samoa, Sao Tome and Principe, Seychelles, Singapore, Solomon Islands, St. Kitts & Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Timor-Leste, Tonga, Trinidad and Tobago, Tuvalu, US Virgin Islands, and Vanuatu.

Bali Action Plan (BAP)

- Included in the Bali Road Map, agreed at the Conference of the Parties in Bali, Indonesia in 2007 (COP13), introduced AWG-LCA.

Bali Road Map

- The Bali Road Map was adopted at the 13th Conference of the Parties and the 3rd Meeting of the Parties in December 2007 in Bali.
- The Road Map is a set of a forward-looking decisions that represent the work that needs to be done under various negotiating "tracks" that is essential to reaching a secure climate future.
- It includes the Bali Action Plan, which charts the course for a new negotiating process designed to tackle climate change, with the aim of completing this by 2009.
- It also includes the AWG-KP negotiations, the launch of the Adaptation Fund, the scope and content of the Article 9 review of the Kyoto Protocol, as well as decisions on technology transfer and on reducing emissions from deforestation.

Biomass fuels or biofuels

- A fuel produced from dry organic matter or combustible oils produced by plants.
- These fuels are considered renewable as long as the vegetation producing them is maintained or replanted, such as firewood, alcohol fermented from sugar, and combustible oils extracted from soy beans.
- Their use in place of fossil fuels cuts greenhouse gas emissions because the plants that are the fuel sources capture carbon dioxide from the atmosphere.

Carbon market

- A popular (but misleading) term for a trading system through which countries may buy or sell units of greenhouse-gas emissions in an effort to meet their national limits on emissions, either under the Kyoto Protocol or under other agreements, such as that among member states of the European Union.
- The term comes from the fact that carbon dioxide is the predominant greenhouse gas, and other gases are measured in units called "carbon-dioxide equivalents."

Cartagena Group

- A collection of 27 countries seeking ambitious outcomes from the UNFCCC process and low carbon domestic output. Founded in 2010.
- Participating countries include Antigua and Barbuda, Australia, Bangladesh, Belgium, Colombia, Costa Rica, Ethiopia, France, Germany, Ghana, Indonesia, Malawi, Maldives, Marshall Islands, Mexico, Netherlands, New Zealand, Norway, Peru, Samoa, Spain, Tanzania, Thailand, Timor-Leste, Uruguay, UK and the European Commission.

Certified emission reductions (CER)

- A Kyoto Protocol unit equal to 1 metric tonne of CO_2 equivalent. CERs are issued for emission reductions from CDM project activities.
- Two special types of CERs called temporary certified emission reduction (tCERs) and long-term certified emission reductions (lCERs) are issued for emission removals from afforestation and reforestation CDM projects.

Clean Development Mechanism (CDM)

- A mechanism under the Kyoto Protocol through which developed countries may finance greenhouse-gas emission reduction or removal projects in developing countries, and receive credits for doing so which they may apply towards meeting mandatory limits on their own emissions.

"CO_2 equivalent"?

- GHG emissions/removals can be expressed either in physical units (such as grams, tonnes, etc.) or in terms of CO_2 equivalent (grams CO_2 equivalent, tonnes CO_2 equivalent, etc.).
- The conversion factor from physical units to CO_2 equivalent is the Global Warming Potential (GWP) of the corresponding GHG.
- If X Gg of CH_4 is to be expressed in terms of CO2 equivalent, then it is multiplied by 21, which is GWP of CH_4 over 100 years timescale.

Coalition for Rainforest Nations

- A voluntary grouping of largely developing nations with rainforests which addresses issues surrounding environmental sustainability specific to tropical rainforests.
- Participation does not necessarily imply that countries adhere to any specific domestic policies or negotiating positions within the international context.

- At September 2011, the group included Argentina, Bangladesh, Belize, Cameroon, Central African Republic, Chile, Congo, Costa Rica, Cote d'Ivoire, DR Congo, Dominica, Dominican Republic, Ecuador, Equatorial Guinea, El Salvador, Fiji, Gabon, Ghana, Guatemala, Guyana, Honduras, Indonesia, Jamaica, Kenya, Lesotho, Liberia, Madagascar, Malaysia, Nicaragua, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Samoa, Sierra Leone, Solomon Islands, Suriname, Thailand, Uruguay, Uganda, Vanuatu and Vietnam.
- Countries participate on a voluntarily basis primarily through unified negotiating positions, workshops and collaborative programs.

Emission reduction unit (ERU)

- A Kyoto Protocol unit equal to 1 metric tonne of CO_2 equivalent. ERUs are generated for emission reductions or emission removals from joint implementation projects.

Emissions trading

- One of the three Kyoto mechanisms, by which an Annex I Party may transfer Kyoto Protocol units to, or acquire units from, another Annex I Party.
- An Annex I Party must meet specific eligibility requirements to participate in emissions trading.

Fugitive fuel emissions

- Greenhouse-gas emissions as by-products or waste or loss in the process of fuel production, storage, or transport, such as methane given off during oil and gas drilling and refining, or leakage of natural gas from pipelines

Global warming potential (GWP)

- An index representing the combined effect of the differing times greenhouse gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation.

Greenhouse gases (GHGs)

- The atmospheric gases responsible for causing global warming and climate change. The major GHGs are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N20).
- Less prevalent --but very powerful -- greenhouse gases are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6).

"Hot air"

- Refers to the concern that some governments will be able to meet their targets for greenhouse-gas emissions under the Kyoto Protocol with minimal effort and could then flood the market with emissions credits, reducing the incentive for other countries to cut their own domestic emissions.

Intergovernmental Panel on Climate Change (IPCC)

- Established in 1988 by the World Meteorological Organization and the UN Environment Programme, the IPCC surveys world-wide scientific and technical literature and publishes assessment reports that are widely recognized as the most credible existing sources of information on climate change.
- The IPCC also works on methodologies and responds to specific requests from the Convention's subsidiary bodies. The IPCC is independent of the Convention.

Land use, land-use change, and forestry (LULUCF)

- A greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities.

Least Developed Countries Fund

- The LDCF was established to support a work programme to assist Least Developed Country Parties (LDCs) carry out, inter alia, the preparation and implementation of national adaptation programmes of action (NAPAs).
- The Global Environment Facility (GEF), as the entity that operates the financial mechanism, has been entrusted to operate this fund.

Protocol

- An international agreement linked to an existing convention, but as a separate and additional agreement which must be signed and ratified by the Parties to the convention concerned.
- Protocols typically strengthen a convention by adding new, more detailed commitments.

Quantified Emissions Limitation and Reduction Commitments (QELROs)

- Legally binding targets and timetables under the Kyoto Protocol for the limitation or reduction of greenhouse-gas emissions by developed countries.

Registries, registry systems

- Electronic databases that tracks and records all transactions under the Kyoto Protocol's greenhouse-gas emissions trading system (the "carbon market") and under mechanisms such as the Clean Development Mechanism.
- "Registry" may also refer to current discussions on a system for inscribing nationally appropriate mitigation actions.

Rio Conventions

- Three environmental conventions, two of which were adopted at the 1992 "Earth Summit" in Rio de Janeiro: the United Nations Framework Convention on Climate Change (UNFCCC), and the Convention on Biodiversity (CBD), while the third, the United Nations Convention to Combat Desertification (UNCCD), was adopted in 1994.
- The issues addressed by the three treaties are related -- in particular, climate change can have adverse effects on desertification and biodiversity -- and through a Joint Liaison Group, the secretariats of the three conventions take steps to coordinate activities to achieve common progress.

Rio+20

- The United Nations Conference on Sustainable Development, to be held in Rio de Janeiro, Brazil, on June 4-6, 2012.
- The first UN Conference on Sustainable Development was the "Earth Summit", held in 1992, and it spawned the three "Rio Conventions"-- the UNFCCC, the UNCCD, and the UNCBD.

Special Climate Change Fund (SCCF)

- The Special Climate Change Fund (SCCF) was established under the Convention in 2001 to finance projects relating to: adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification.
- The Global Environment Facility (GEF), as an operating entity of the financial mechanism, has been entrusted to operate the SCCF.

"Spill-over effects" (also referred to as "rebound effects" or "take-back effects")

- Reverberations in developing countries caused by actions taken by developed countries to cut greenhouse-gas emissions.
- For example, emissions reductions in developed countries could lower demand for oil and thus international oil prices, leading to more use of oil and greater emissions in developing nations, partially off-setting the original cuts.
- Current estimates are that full-scale implementation of the Kyoto Protocol may cause 5 to 20 per cent of emissions reductions in industrialized countries to "leak" into developing countries.

Umbrella group

- A loose coalition of non-European Union developed countries formed following the adoption of the Kyoto Protocol.
- Although there is no formal membership list, the group usually includes Australia, Canada, Iceland, Japan, New Zealand, Norway, the Russian Federation, Ukraine, and the United States.

2 degrees C goal

- A 2 degrees Celsius/Centigrade rise in global temperatures from pre-industrial levels is the highest rise we can afford if we want a 50% chance of avoiding the worst effects of climate change.
- The current concentration of carbon dioxide in the atmosphere is 370 parts per million
- The concentration of carbon dioxide equivalent in the atmosphere that the world must stay at or under to stay true to the 2 degrees Celsius goal is 450 parts per million.

◆◆◆◆◆◆

APPENDIX

1. Ramsar wetland sites in India

S.No	Name	State
1.	Ashtamudi Wetland	Kerala
2.	Bhitarkanika Mangroves	Orissa
3.	Bhoj Wetland	Madhya Pradesh
4.	Chandra Taal	Himachal Pradesh
5.	Chilika Lake	Orissa
6.	Deepor Beel	Assam
7.	East Calcutta Wetlands	West Bengal
8.	Harike Wetland	Punjab
9.	Hokersar Wetland	Jammu and Kashmir
10.	Kanjli Wetland	Punjab
11.	Keoladeo National Park	Rajasthan
12.	Kolleru Lake	Andhra Pradesh
13.	Loktak Lake	Manipur
14.	Nalsarovar Bird Sanctuary	Gujarat
15.	Point Calimere Wildlife and Bird Sanctuary	Tamil Nadu
16.	Pong Dam Lake	Himachal Pradesh
17.	Renuka Wetland	Himachal Pradesh
18.	Ropar	Punjab
19.	Rudrasagar Lake	Tripura
20.	Sambhar Lake	Rajasthan
21.	Sasthamkotta Lake	Kerala
22.	Surinsar-Mansar Lakes	Jammu and Kashmir
23.	Tsomoriri	Jammu and Kashmir
24.	Upper Ganga River (Brijghat to Narora Stretch)	Uttar Pradesh
25.	Vembanad-Kol Wetland	Kerala
26.	Wular Lake	Jammu and Kashmir

2. Project Tiger Reserves of India

S.No	Name of PTR	State
1.	Achanakmar	Chhattishgarh
2.	Annamalai	Tamil Nadu
3.	Bandhavgarh	Madhya Pradesh
4.	Bandipur	Karnataka
5.	Bhadra	Karnataka
6.	Buxa	West Bengal
7.	Corbett	Uttarakhand
8.	Dampa	Mizoram
9.	Dandeli-Anshi	Karnataka
10.	Dudhwa	Uttar Pradesh
	Katerniaghat Extension	Uttar Pradesh
11.	Indravati	Chhattishgarh
12.	Kalakad-Mundathurai	Tamil Nadu
13.	Kanha	Madhya Pradesh
14.	Kaziranga	Assam
15.	Manas	Assam
16.	Melghat	Maharashtra
17.	Mudumalai	Tamil Nadu
18.	Nagarhole	Karnataka
19.	Nagarjunsagar-Srisailam	Andhra Pradesh
20.	Namdapha	Arunachal Pradesh
21.	Nameri	Assam
22.	Pakhui / Pakke	Arunachal Pradesh
23.	Palamau	Jharkhand
24.	Panna	Madhya Pradesh
25.	Parambikulam	Kerala
26.	Pench (Maharashtra)	Maharashtra
27.	Pench (M.P.)	Madhya Pradesh
28.	Periyar	Kerala
29.	Ranthambhore	Rajasthan
30.	Sanjay Dubri	Madhya Pradesh

31.	Satkosia	Orissa
32 .	Satpura	Madhya Pradesh
33.	Sariska	Rajasthan
34.	Shahyadri	Maharashtra
35.	Simlipal	Orissa
36.	Sunderbans	West Bengal
37.	Tadoba-Andhari	Maharashtra
38.	Udanti-Sitanadi	Chhattishgarh
39.	Valmiki	Bihar
40.	B.R.Hills	Karnataka
41.	Kawal	Andhra pradesh
42.	Sathyamangalam	Tamil Nadu
43.	Mukunda Hills	Rajasthan

3. Elephant Reserves of India

Sl.No	ELEPHANT RANGE	ELEPHANT RESERVE	STATE
1.	East-Central Landscape (South-West Bengal-Jharkhand - Orissa)	1. Mayurjharna ER 2. Singhbhum ER 3. Mayurbhanj ER 4. Mahanadi ER 5. Sambalpur ER 6. Baitami ER 7. South Orissa ER 8. Lemru ER 9. Badalkhol - Tamorpingla ER	West Bengal Jharkhand Orissa Orissa Orissa Orissa Orissa Chhattishgarh Chhattishgarh
2.	Kameng-Sonitpur Landscape (Arunachal - Assam) Total	10. Kameng ER 11. Sonitpur ER	Arunachal Assam
3.	Eastern-South Bank Landscape (Assam - Arunachal)	12. Dihing-Patkai ER 13. South Arunachal ER	Assam Arunachal
4.	Kaziranga-Karbi Anglong-Intanki Landscape (Assam - Nagaland)	14. Kaziranga-Karbi Anglong ER 15. Dhansiri-Lungding ER 16. Intanki ER	Assam Assam Nagaland
5.	North Bengal- Greater Manas Landscape (Assam - West Bengal)	17. Chirang-Ripu ER 18. Eastern Dooars ER	Assam West Bengal
6.	Meghalaya Landscape (Meghalaya)	19. Garo Hills ER 20. Khasi-hills ER	Meghalaya Meghalaya
7.	Brahmagiri-Nilgiri-Eastern Ghat Landscape (Karnataka - Kerala-Tamilnadu- Andhra)	21. Mysore ER 22. Wayanad ER 23. Nilgiri ER 24. Rayala ER 25. Nilambur ER 26. Coimbatore ER	Karnataka Kerala Tamil Nadu Andhra pradesh Kerala Tamil Nadu
8.	Anamalai-Nelliampathy- High Range Landscape (Tamilnadu - Kerala)	27. Anamalai ER 28. Anamudi ER	Tamil Nadu Kerala
9.	Periyar-Agasthyamalai Landscape (Kerala - Tamilnadu)	29. Periyar ER 30. Srivilliputhur ER	Kerala Tamil Nadu
10.	North-Western Landscape (Uttarakhand - Uttar Pradesh)	31. Shivalik ER 32. Uttar Pradesh ER	Uttarakhand U.P.

4. List of Key Activities and Likely Associated Air Pollutants

S. No.	Activity	Significant Air Pollutants
A.	**EIA Notifications, 1994**	
1.	Nuclear Power Plants	Tritium, Radioactive elements
2.	River Valley Projects	TSPM/RPM, HC, CO etc.
3.	Air Ports, Ports/Harbours	TSPM/RPM, HC, NOx, etc.
4.	Petroleum Refineries	SO2, HC, Mercaptan, VOCs
5.	Chemical fertiliser	TSPM/RPM, Fluoride, Ammonia, NOx,SO2
6.	Pesticides	Odour, VOCs, HC, Cl2
7.	Petrochemicals	TSPM/RPM, SO2, NOx, CO, HC, VOCs
8.	Bulk Drugs & Pharmaceuticals	TSPM/RPM, VOCs
9.	Exploration of Oil & Gas and their production, transportation and storage	TSPM/RPM, HC, CO
10.	Synthetic Rubber	TSPM/RPM, SO2, HC
11.	Asbestos and Asbestos products	TSPM/RPM, fibre
12.	Hydrocyanic acid and its derivatives	HCN Vapours
13.	Metallurgical industries	TSPM/RPM, SO2, CO, NOx Fluoride etc.
14.	Electric arc furnaces	TSPM/RPM, NOx,
15.	Chlor-alkali industry	Hg, Cl2, HCl vapours, H2
16.	Integrated paint complex	TSPM/RPM, SO2, Volatile Organic
17.	Viscose Staple fibre and filament yarn	H2S, CS2, SO2
18.	Storage batteries	TSPM/RPM, Pb
19.	Tourism Project	TSPM/RPM,
20.	Thermal Power Plants	TSPM/RPM, SO2, NOx.
21.	Mining Activities	TSPM/RPM, HC etc.
22.	Highway Projects	TSPM/RPM, HC, NOx CO.
23.	Tarred roads in Himalayas	TSPM/RPM, HC, NOx CO.
24.	Distilleries	TSPM/RPM, SO2
25.	Raw Skins and Hides	-
26.	Pulp and Paper	TSPM/RPM, H2S, Mercaptan
27.	Dyes	TSPM/RPM, SO2, NOx
28.	Cement	TSPM/RPM, NOx
29.	Foundries	TSPM/RPM, SO2, CO, Metal Fumes
30.	Electroplating	TSPM/RPM, Fumes of HCN, HCl Acid Fumes

Note:

- TSPM – Total Suspended Particulate Matter
- RPM – Respirable Particulate Matter
- VOCs – Volatile Organic Compounds
- HCN Vapours – Hydrogen Cyanide

5 Mike Sites in India

S.No	Name	State
1.	Chirang Ripu	Assam
2.	Dhang Patki	Assam
3.	Eastern Dooars	WB
4.	Deomali	Arun Pradesh
5.	Garo Hills	Meghalaya
6.	Mayurbhanj	Orissa
7.	Mysore	Karnataka
8.	Nilgiri	Tamil Nadu
9.	Shivalik	Uttarakhand
10.	Wayanad	Kerala

6. Biosphere reserves

S.No	Name	Location (State)
1.	Achanakamar - Amarkantak	Covers parts of Anupur and Dindori districts of M.P. and parts of Bilaspur districts of Chhattishgarh State.
2.	Agasthyamalai	Neyyar, Peppara and Shendurney Wildlife Sanctuaries and their adjoining areas in Kerala.
3.	Cold Desert	Pin Valley National Park and surroundings; Chandratal and Sarchu & Kibber Wildlife Sancturary in Himachal Pradesh
4.	Dehang-Dibang	Part of Siang and Dibang Valley in Arunachal Pradesh.
5.	Dibru-Saikhowa	Part of Dibrugarh and Tinsukia Districts (Assam)
6.	Great Nicobar	Southern most islands of Andaman And Nicobar (A&N Islands).
7.	Gulf of Mannar	Indian part of Gulf of Mannar between India and Sri Lanka (Tamil Nadu).
8.	Kachchh	Part of Kachchh, Rajkot, Surendra Nagar and Patan Civil Districts of Gujarat State
9.	Khang chendzonga	Parts of Khang chendzonga hills and Sikkim.
10.	Manas	Part of Kokrajhar, Bongaigaon, Barpeta, Nalbari, Kamprup and Darang districts (Assam)
11.	Nanda Devi	Part of Chamoli, Pithoragarh, and Bageshwar districts (Uttarakhand).
12.	Nilgiri	Part of Wayanad, Nagarhole, Bandipur and Madumalai, Nilambur, Silent Valley and Siruvani hills (Tamil Nadu, Kerala and Karnataka).
13.	Nokrek	Part of Garo hills (Meghalaya).
14.	Pachmarhi	Parts of Betul, Hoshangabad and Chindwara districts of Madhya Pradesh.
15.	Seshachalam Hills	Seshachalam Hill Ranges covering parts of Chittoor and Kadapa districts of Andhra Pradesh
16.	Simlipal	Part of Mayurbhanj district (Orissa).
17.	Sunderbans	Part of delta of Ganges and Brahamaputra river system (West Bengal).

7. List of INDIA 's Biosphere Reserves in UNESCO'S MAB list

S.No	NAME	STATE	YEAR
1.	Nilgiri	Tamil Nadu, Kerala, Karnataka	2000
2.	Gulf of Mannar	Tamil Nadu	2001
3.	Sunderbans	West Bengal	2001
4.	Nanda Devi	Uttarakhand	2004
5.	Nokrek	Meghalaya	2009
6.	Pachmarhi	Madhya Pradesh	2009
7.	Similipal	Orissa	2009
8.	Achanakmar-Amarkantak	Chhattishgarh	2012

8. Community reserve

S.No	Name	Year of Estd.	Distt./State Location
1.	Keshopur Chhamb	2007	Gurdaspur, Punjab
2.	Lalwan	2007	Hoshiarpur, Punjab
3.	Kadalundi	2007	Malappuram, Kerala
4.	Kokkare Bellur	2007	Mandya, Karnataka

9. Mangrove sites in India

State/Union Territories	Mangrove areas	
West Bengal	1.	Sunderbans
Orissa	2.	Bhaitarkanika
	3.	Mahanadi
	4.	Subernarekha
	5.	Devi-Kauda
	6.	Dhamra
	7.	Mangrove Genetic Resources Centre
	8.	Chilka
Andhra Pradesh	9.	Coringa
	10.	East Godavari
	11.	Krishna
Tamil Nadu	12.	Pichavaram
	13.	Muthupet
	14.	Ramnad
	15.	Pulicat
	16.	Kaznuveli
Andaman & Nicobar	17.	North Andamans
	18.	Nicobar
Kerala	19.	Vembanad
	20.	Kannur (Northern Kerala)
Karnataka	21.	Coondapur
	22.	Dakshin Kannada/ Hannavar
	23.	Karwar
	24.	Manglore Forest Division
Goa	25.	Goa
Maharashtra	26.	Achra-Ratnagiri
	27.	Devgarh-Vijay Durg
	28.	Veldur
	29.	Kundalika-Revdanda
	30.	Mumbra-Diva
	31.	Vikroli
	32.	Shreevardhan
	33.	Vaitarna
	34.	Vasai-Manori
	35.	Malvan
Gujarat	36.	Gulf of Kutchh
	37.	Gulf of Khambhat
	38.	Dumas-Ubhrat

◆◆◆◆◆◆